US010888937B2

(12) **United States Patent**
Dieter et al.

(10) **Patent No.: US 10,888,937 B2**
(45) **Date of Patent: Jan. 12, 2021**

(54) **APPARATUS AND METHOD FOR SEVERING AND INSERTING COLLATED T-NUTS**

(75) Inventors: **Jonathan Wayne Dieter**, Painesville, OH (US); **Stephen R. Selle**, Mentor, OH (US)

(73) Assignee: **STAFAST PRODUCTS, INC.**, Painesville, OH (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1596 days.

(21) Appl. No.: **13/313,657**

(22) Filed: **Dec. 7, 2011**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/433,300, filed on Jan. 17, 2011.

(51) **Int. Cl.**
B23D 33/02 (2006.01)
B23P 19/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B23D 33/025*** (2013.01); ***B21K 1/64*** (2013.01); ***B23D 33/02*** (2013.01); ***B23P 19/001*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC B23D 33/02; B23D 33/025; B23P 19/001; B23P 19/062; F16B 27/00; F16B 37/04;
(Continued)

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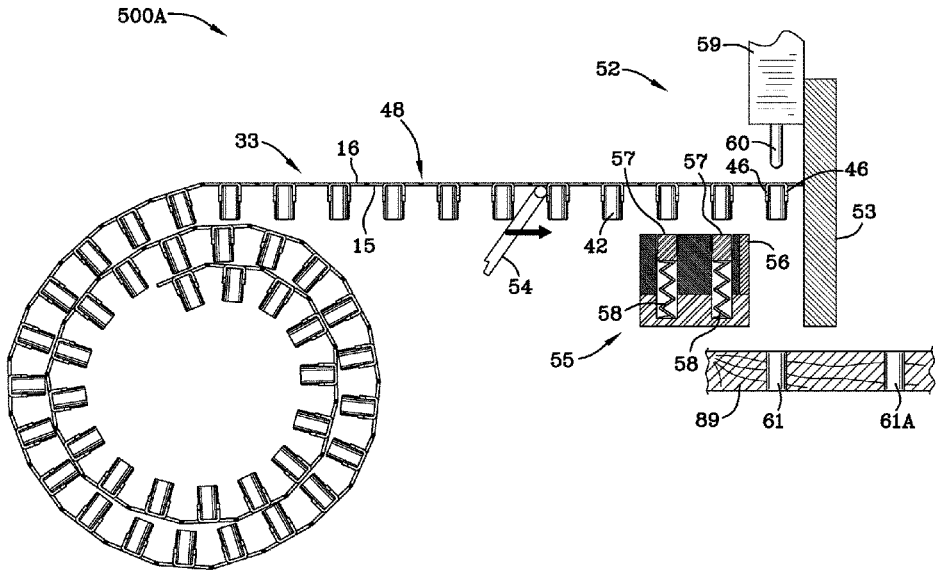
Primary Examiner — Christopher M Koehler
(74) *Attorney, Agent, or Firm* — Woodling, Krost and Rust

(57) **ABSTRACT**

A continuous strip of T-Nuts formed on a common strip of metal. Each T-Nut of the strip of T-Nuts is integrally connected to the next adjacent T-Nut by carry tabs. The carry tabs can be frangible themselves or contain a frangible portion. Each T-Nut includes a cylindrical bore therein and a threaded interior. A mechanism feeds and severs the endmost T-Nut in endwise fashion. The mechanism to feed and sever the endmost T-Nut includes a cutting blade positioned vertically below the frangible portion of the carry tab. A shearing ram having a guide positioned axially in line with the cylindrical bore in the endmost T-Nut is adapted to move vertically from an upper to a lower position to engage the cutting blade with the frangible portion and sever the endmost T-Nut.

18 Claims, 36 Drawing Sheets



(51) **Int. Cl.**

B23P 19/06	(2006.01)
B21K 1/64	(2006.01)
F16B 27/00	(2006.01)
F16B 37/02	(2006.01)
F16B 37/04	(2006.01)

(52) **U.S. Cl.**

CPC ***B23P 19/062*** (2013.01); *F16B 27/00* (2013.01); *F16B 37/02* (2013.01); *F16B 37/04* (2013.01); *Y10T 29/49799* (2015.01); *Y10T 29/49947* (2015.01); *Y10T 29/5198* (2015.01); *Y10T 83/647* (2015.04)

(58) **Field of Classification Search**

CPC Y10T 29/49799; Y10T 29/49947; Y10T 29/5198; Y10T 83/647

USPC 29/417, 413, 787, 798; 227/135, 136, 227/138, 139; 411/84, 443

See application file for complete search history.

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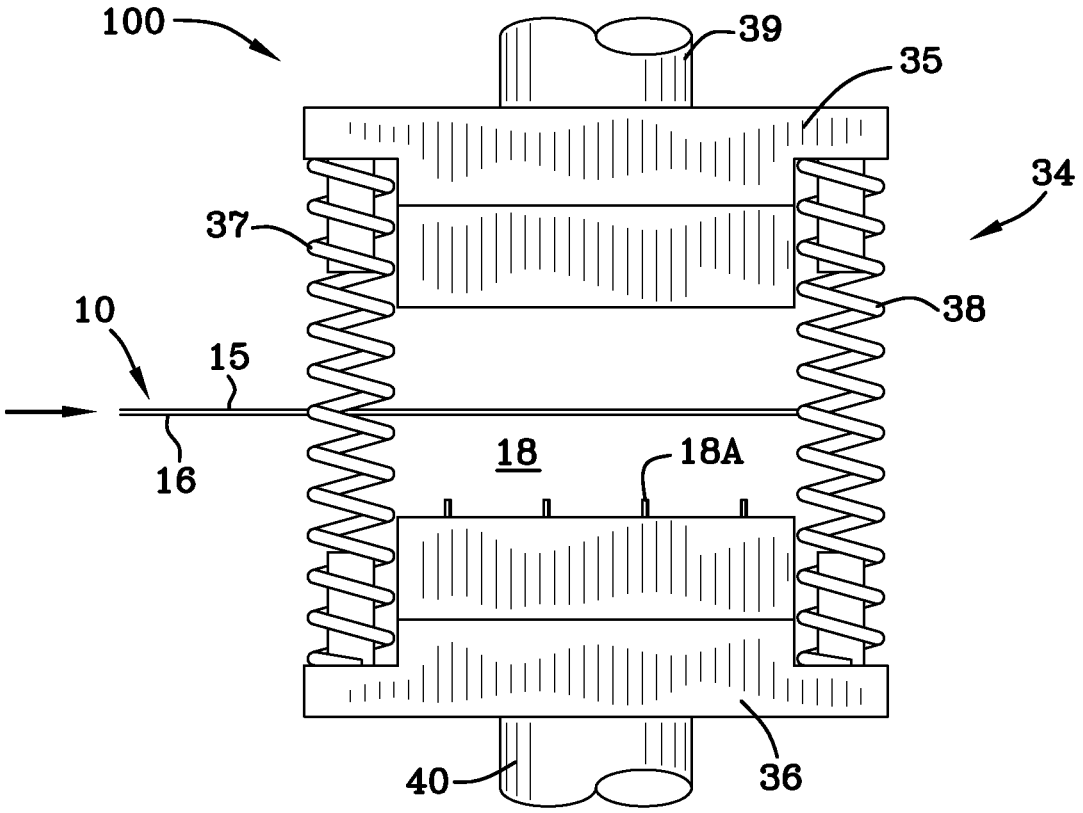
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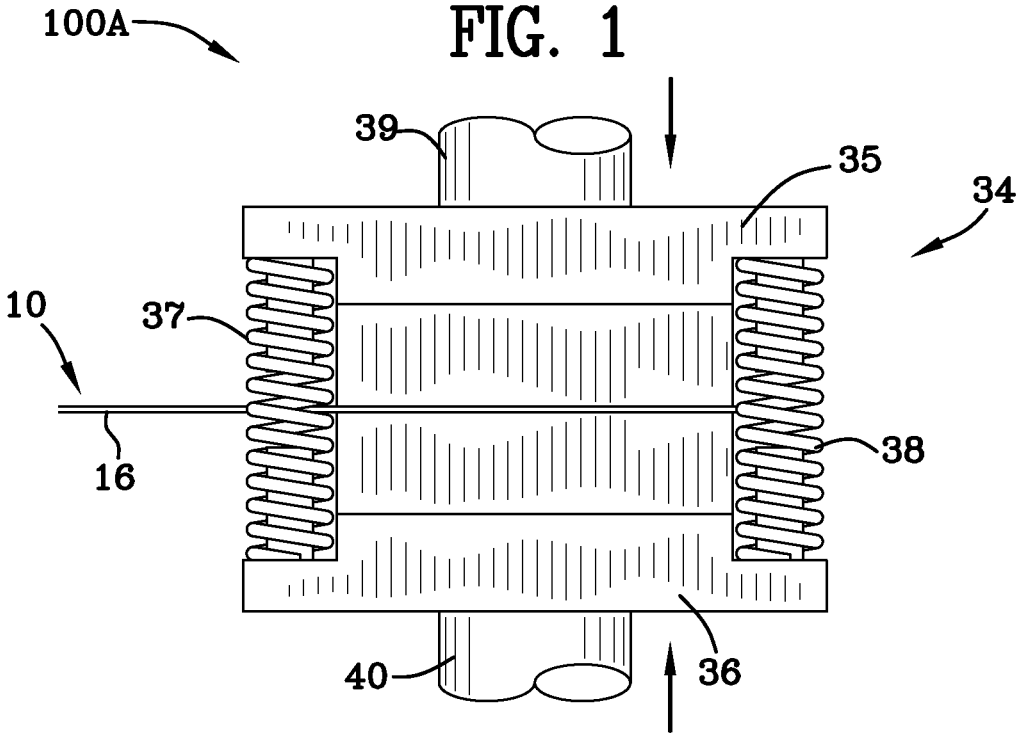
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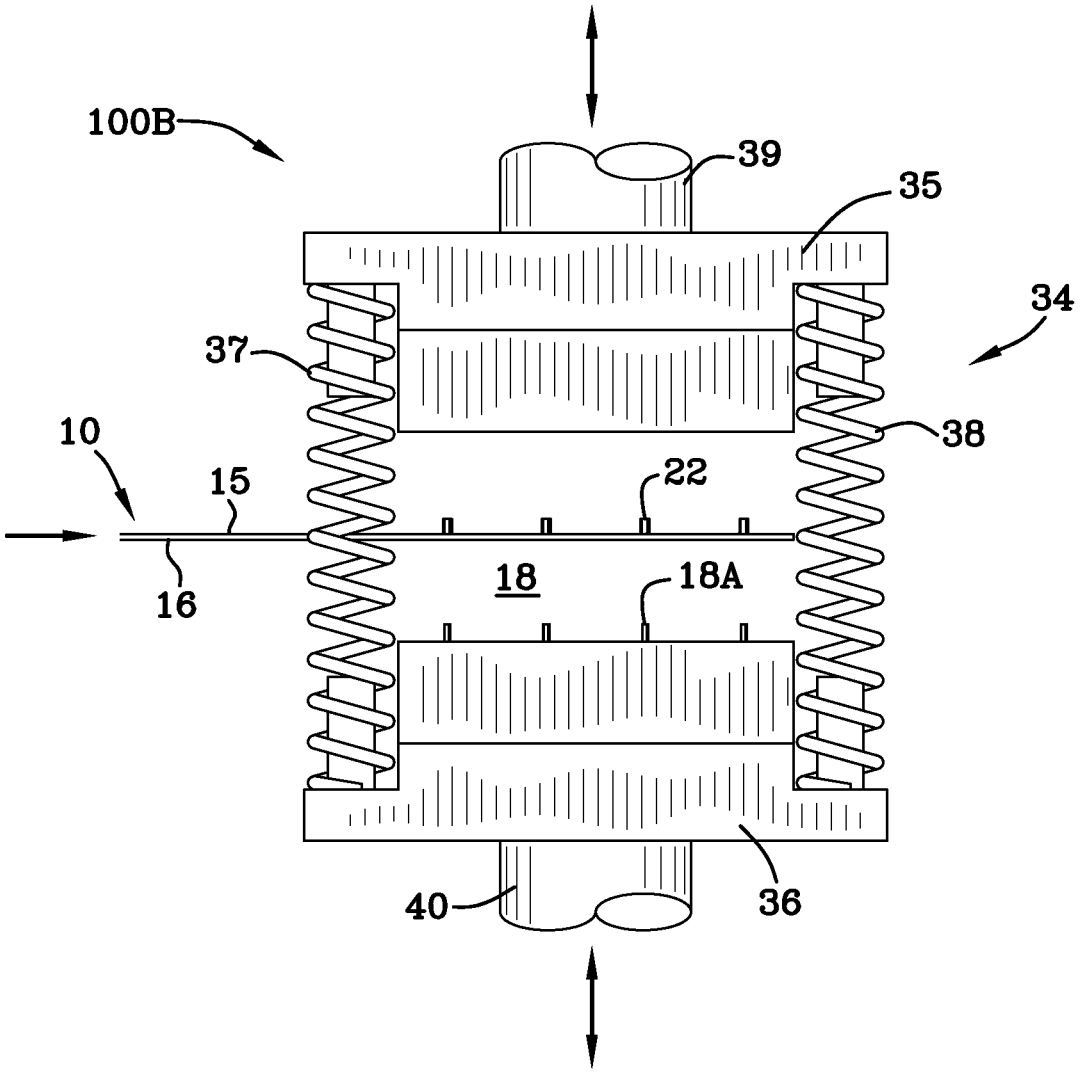

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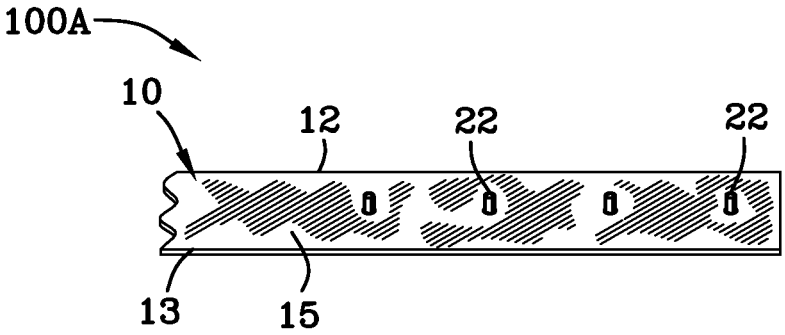

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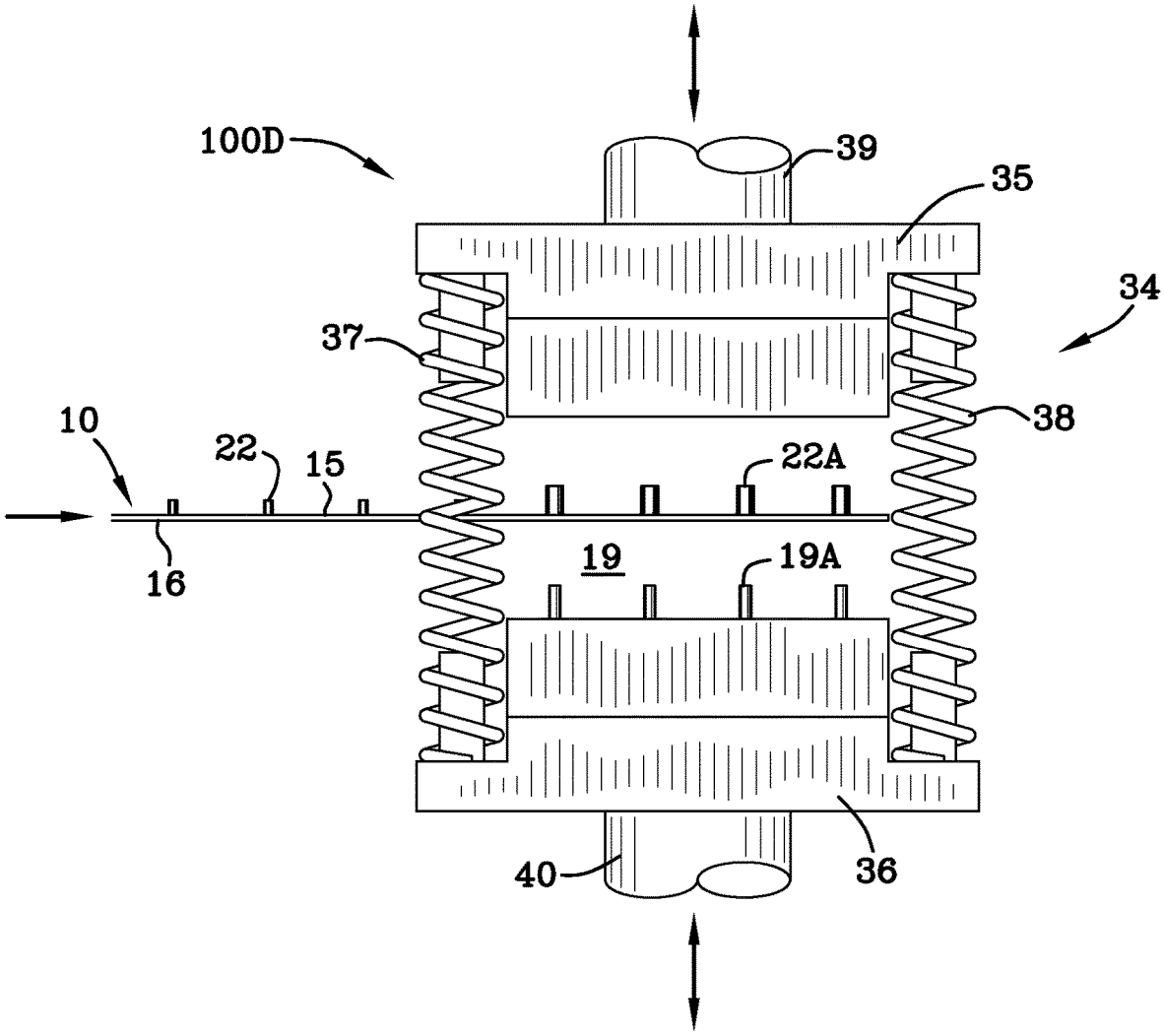
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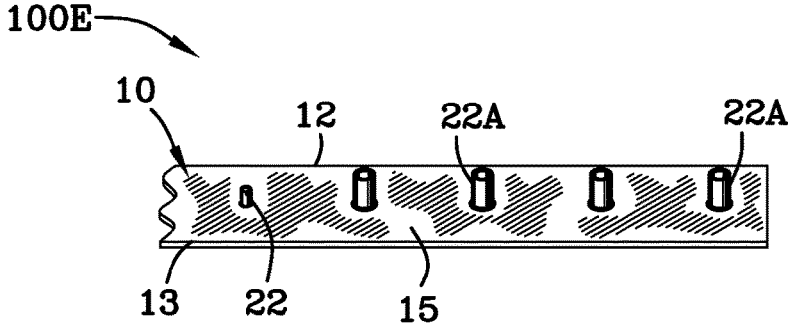
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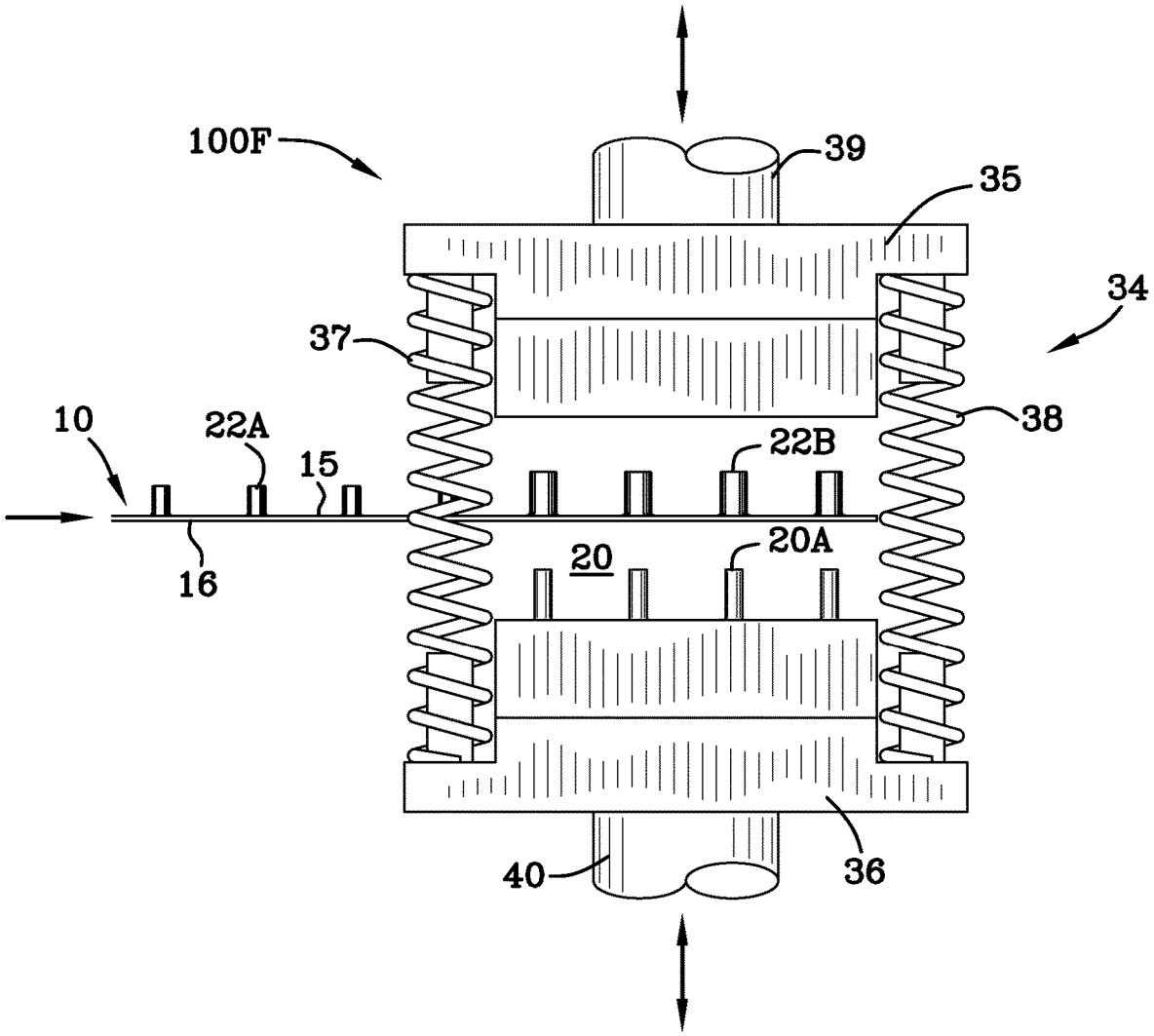
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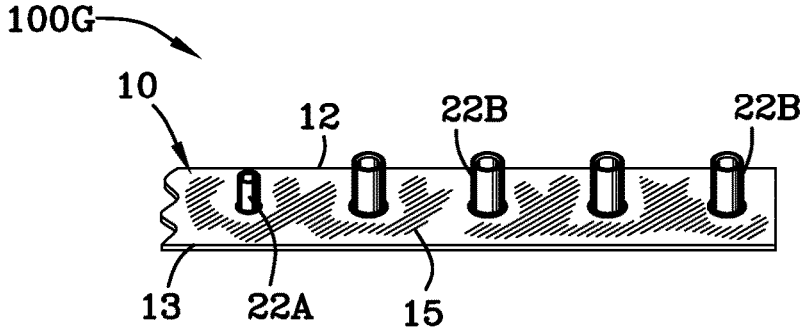
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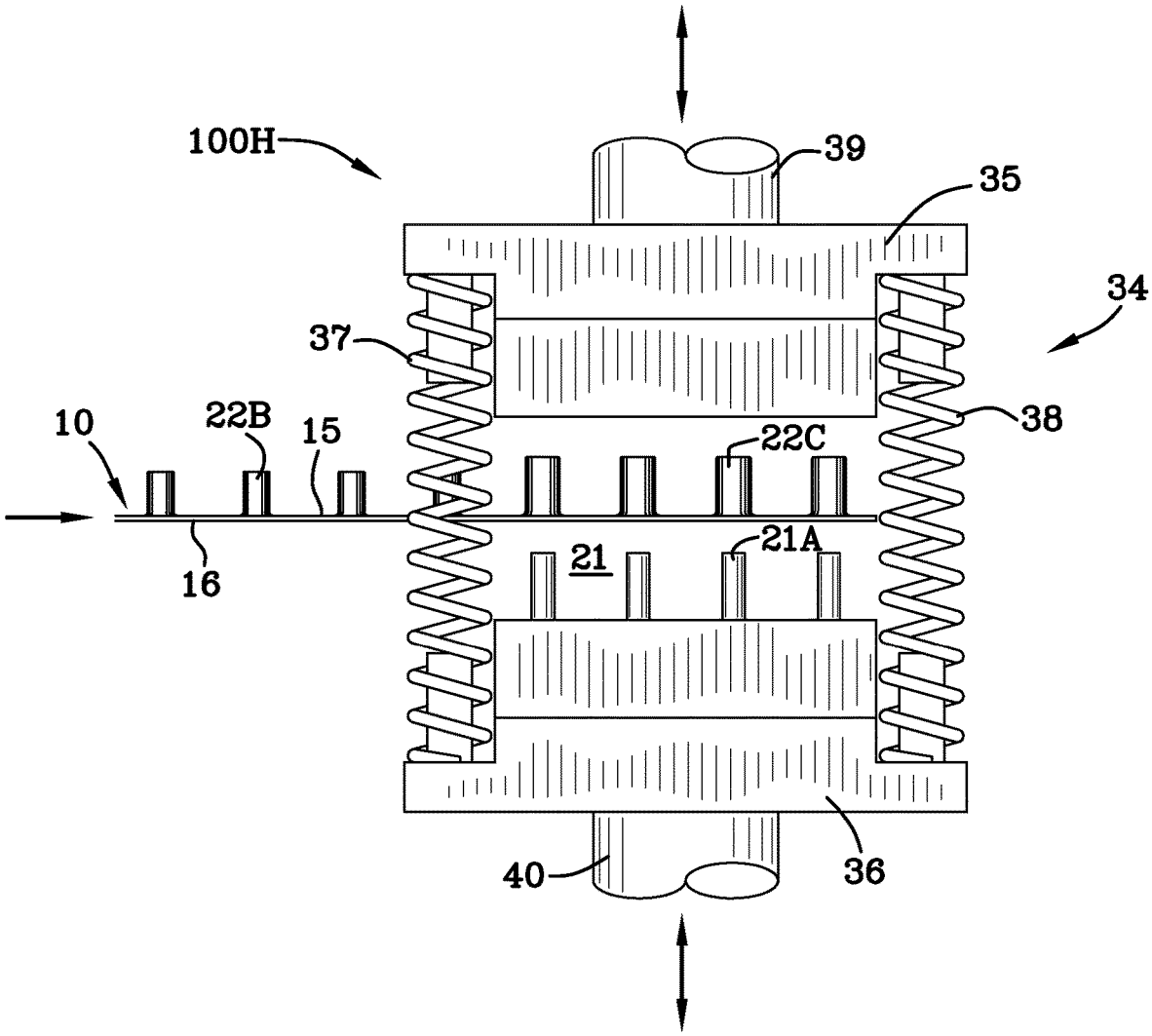
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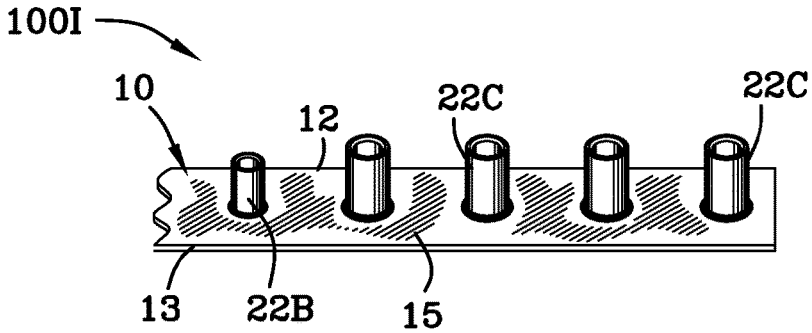
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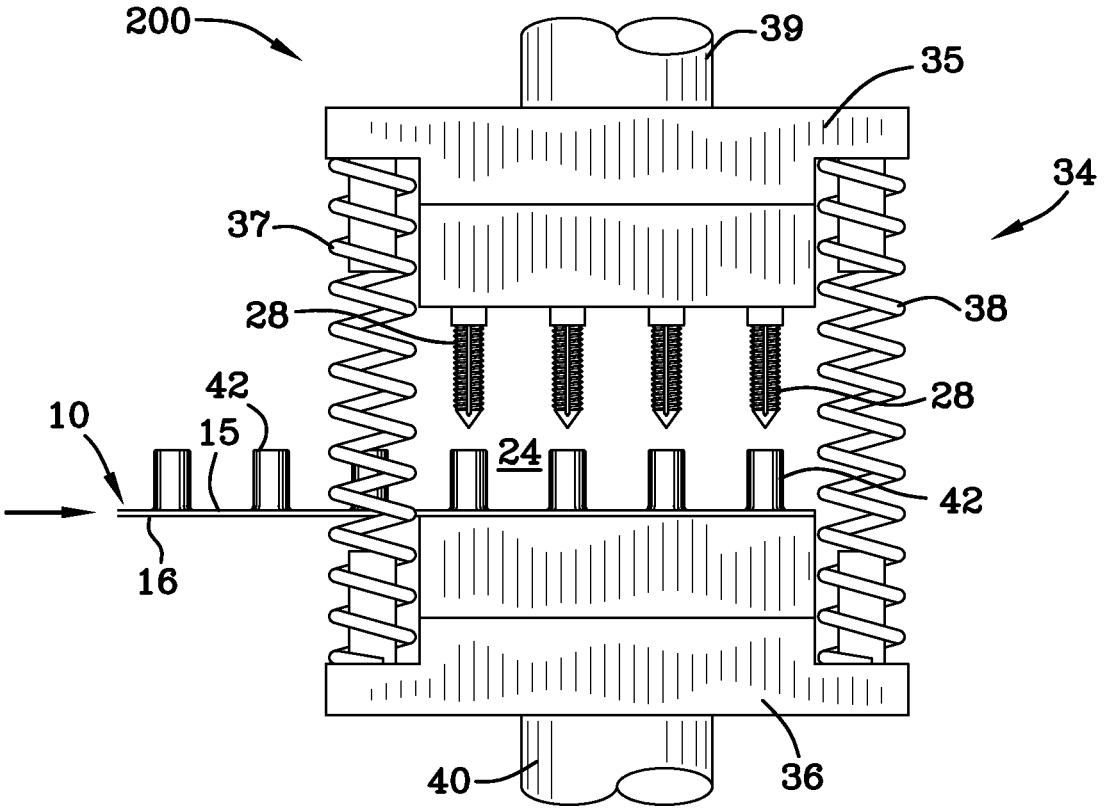
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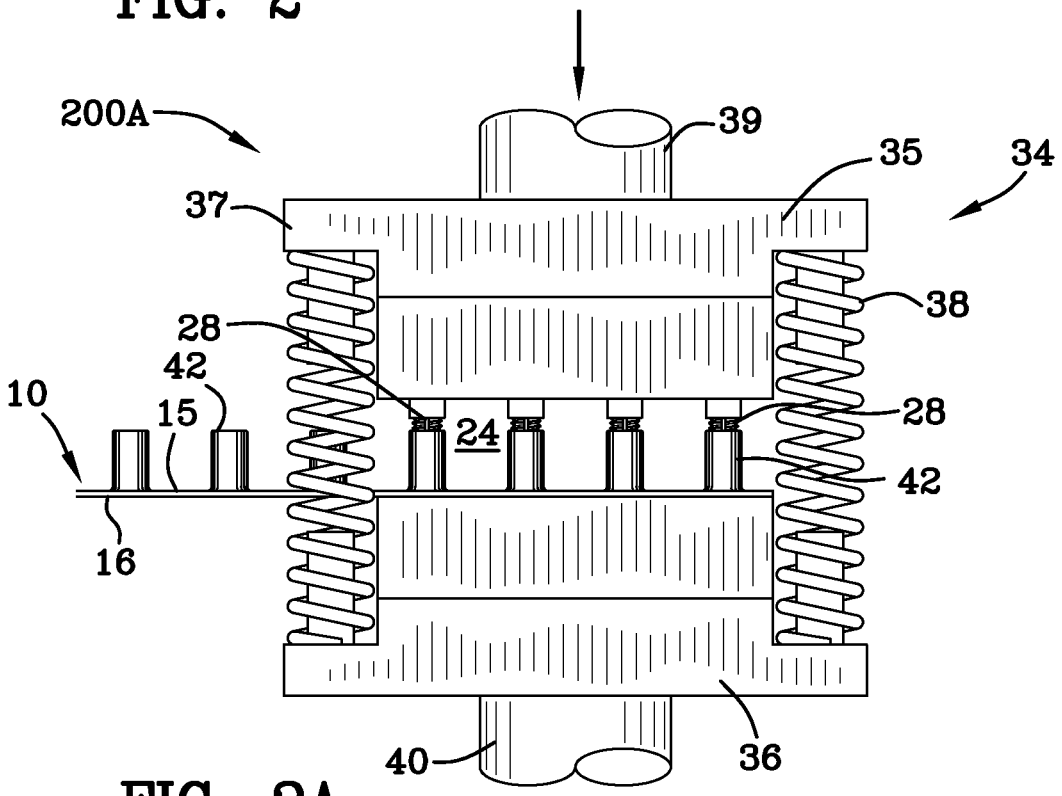
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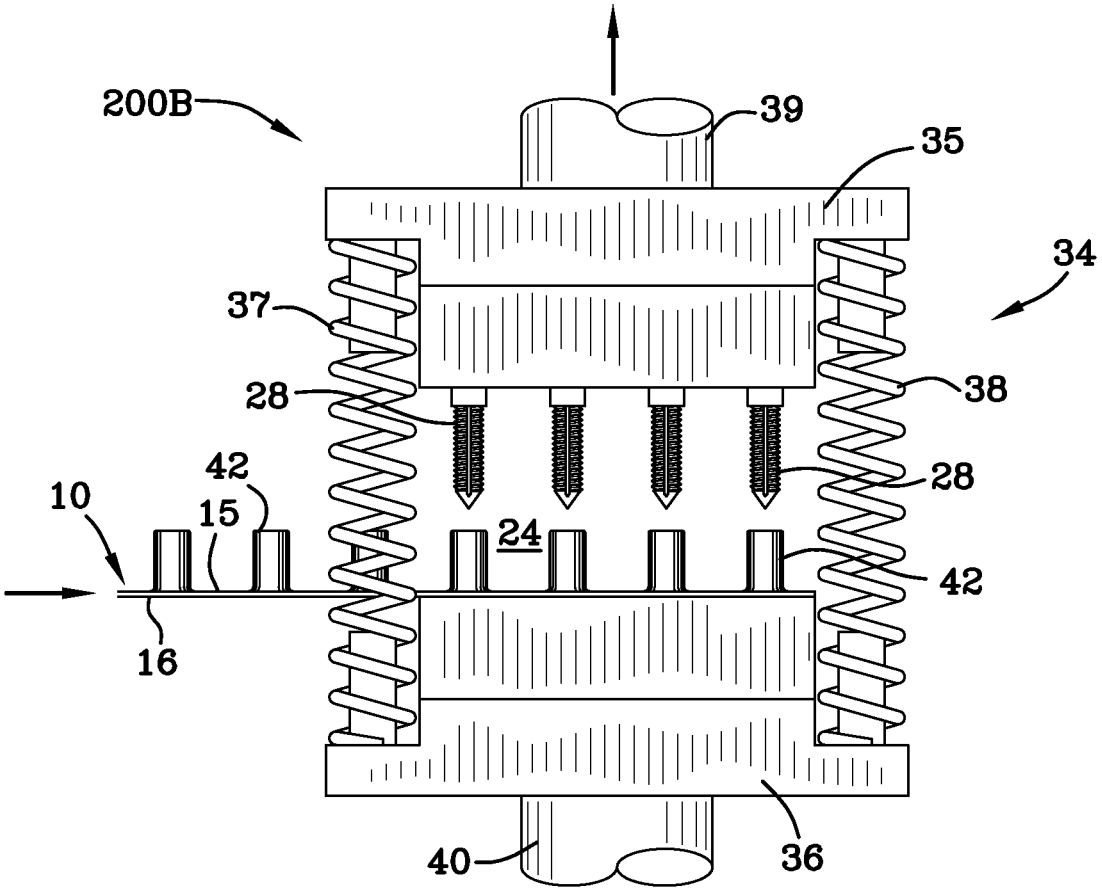
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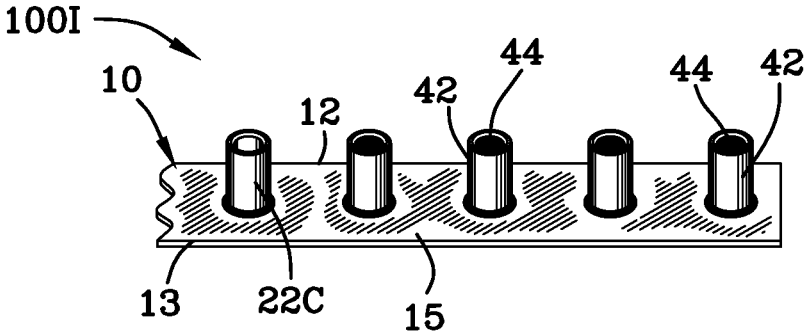
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FIG. 2C

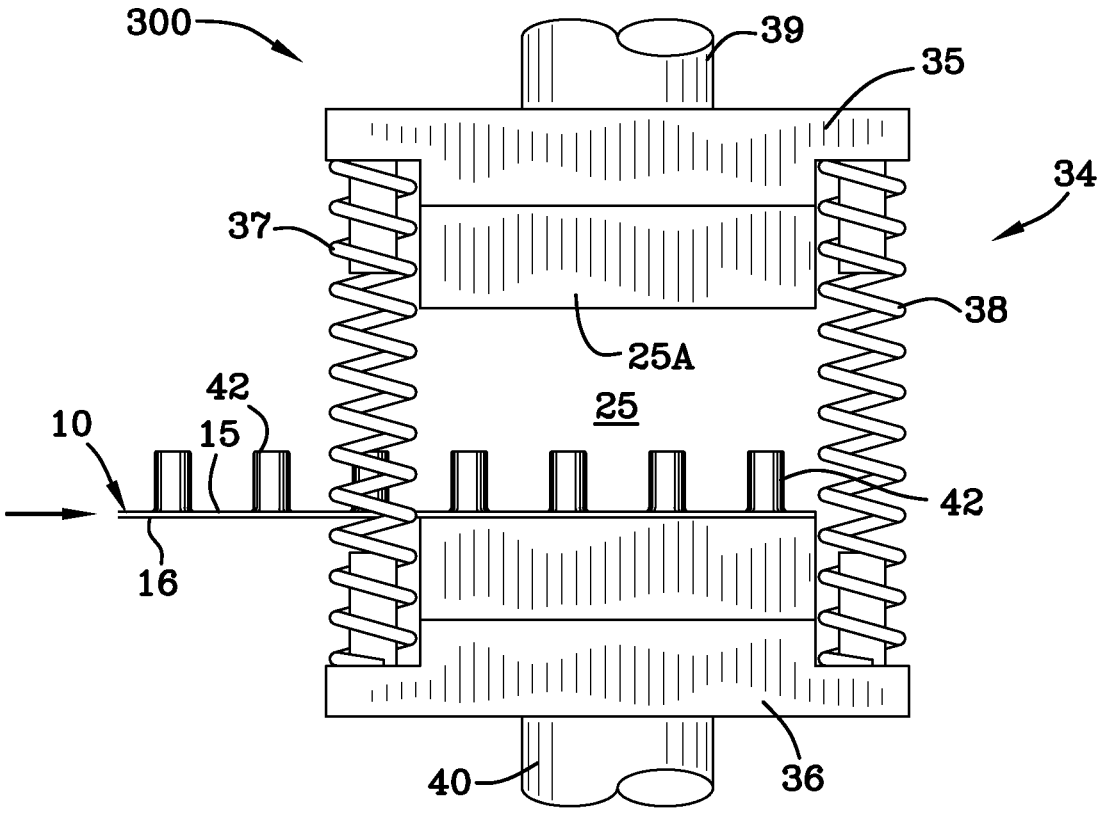
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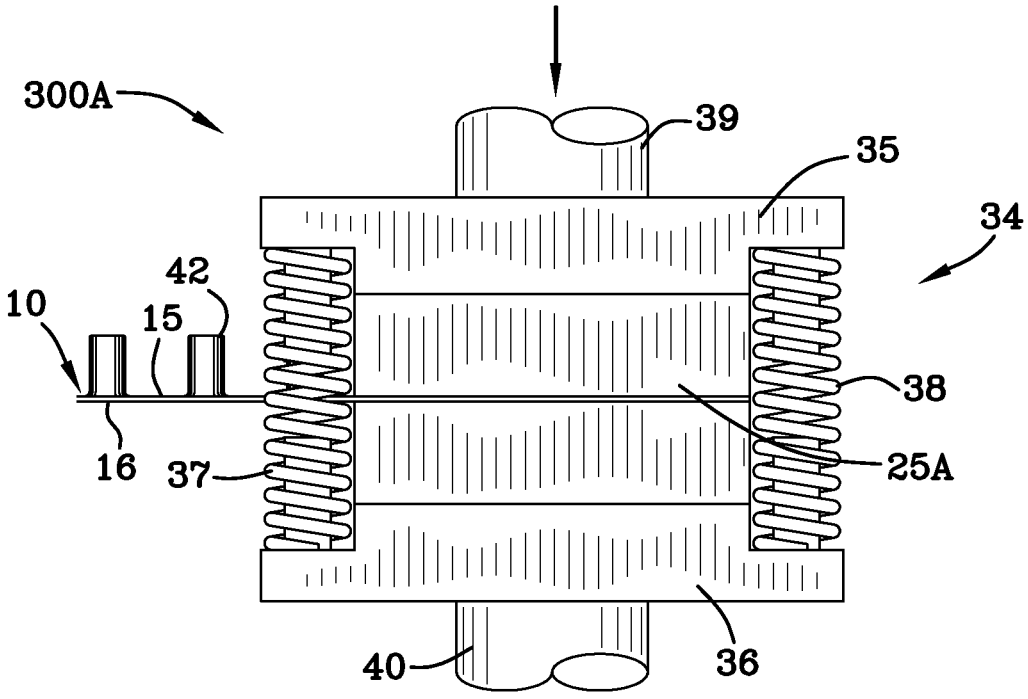
FIG. 3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34
42
10
15
38
16
37
25A
40
36

FIG. 3A

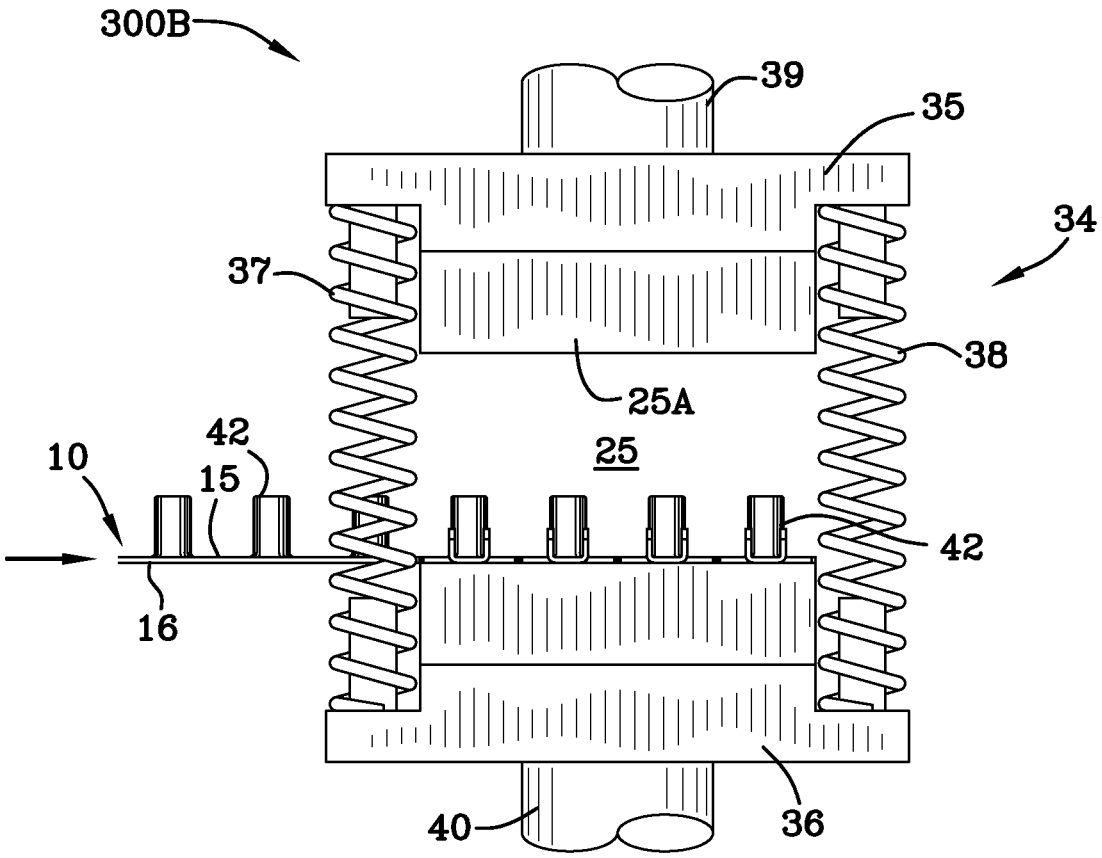

300B
39
35
34
37
38
25A
25
42
10
15
42
16
40
36

FIG. 3B

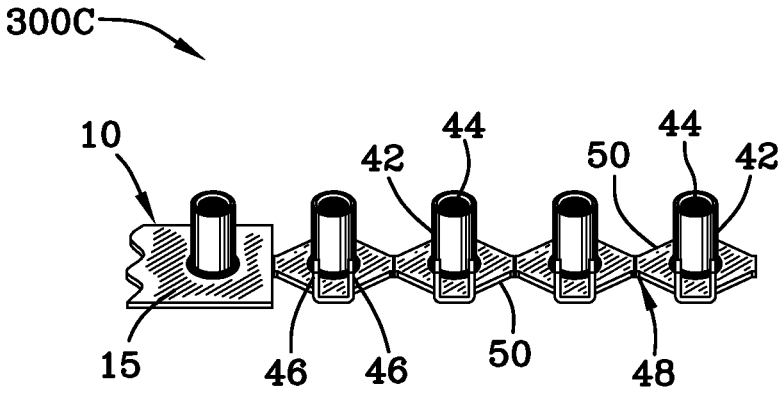

300C
10
44
42
44
50
42
15
46
46
50
48

FIG. 3C

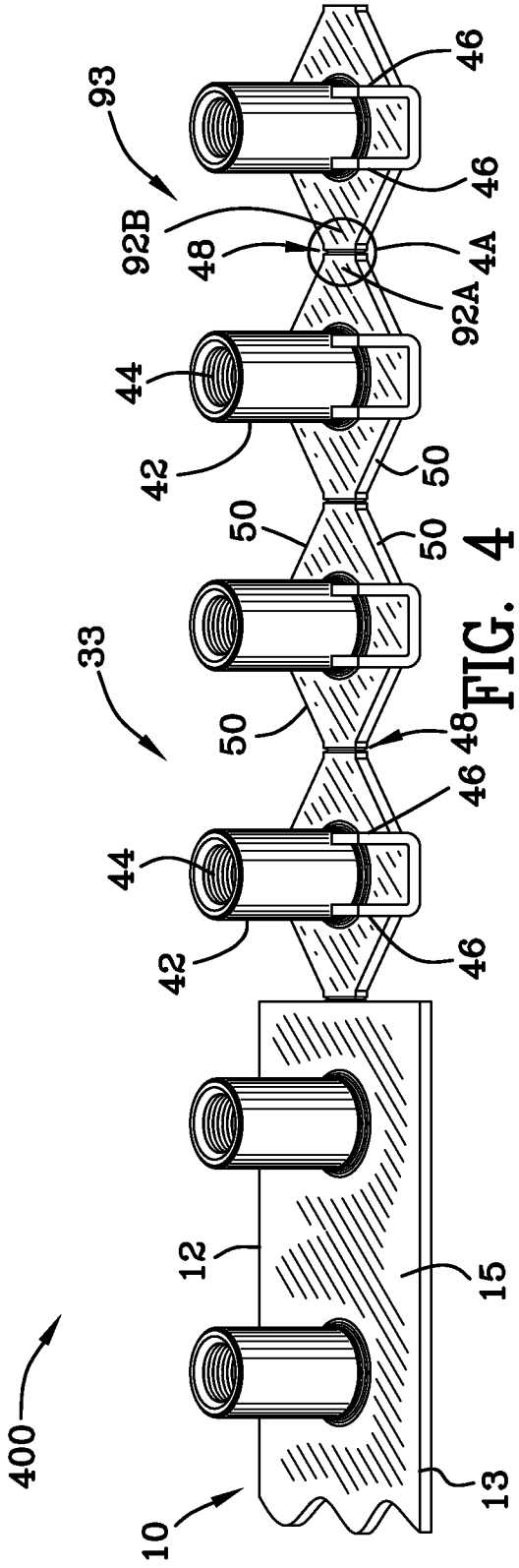

400
10
12
13
15
33
42
44
46
48
50
92A
92B
93
4A

FIG. 4

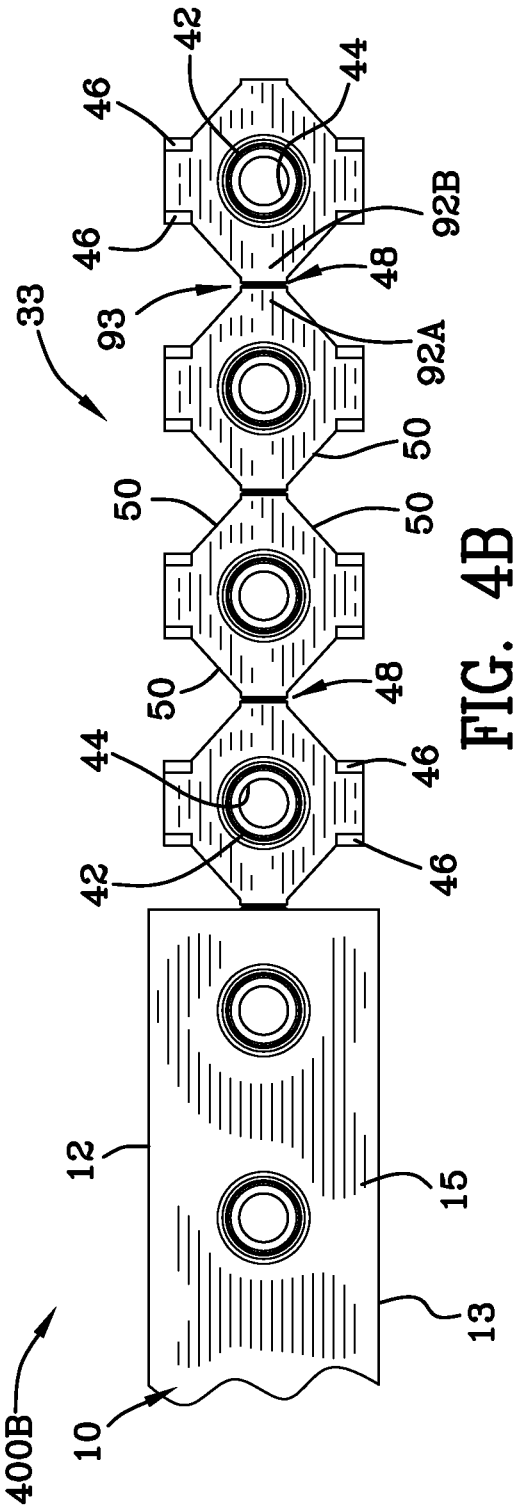

400B
10
12
13
15
33
42
44
46
48
50
92A
92B
93

FIG. 4B

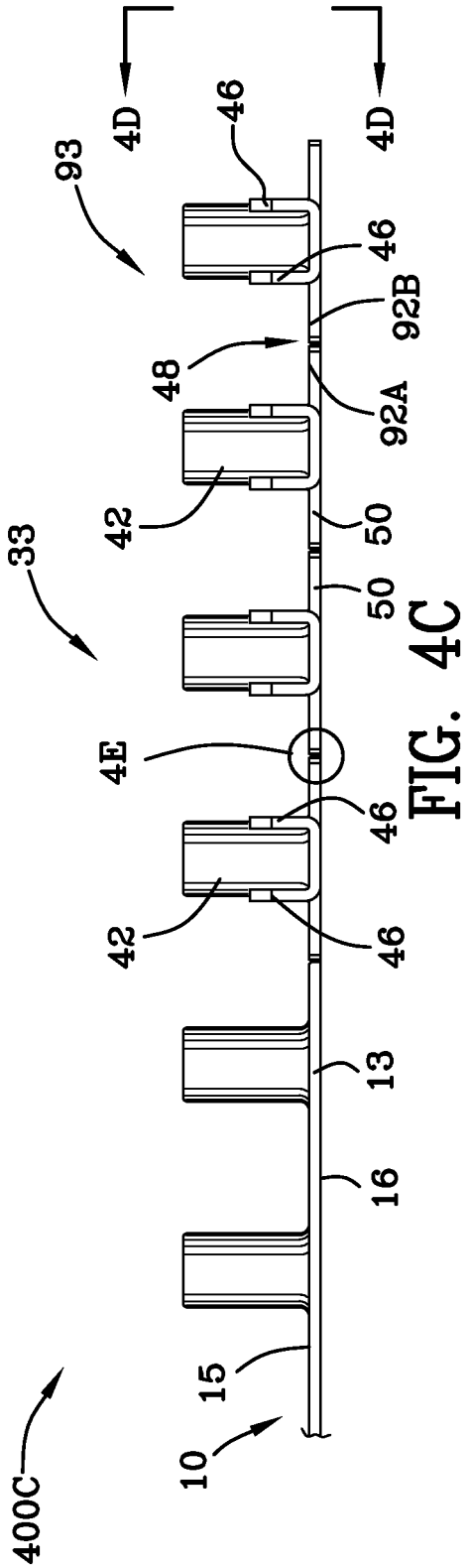


FIG. 4C

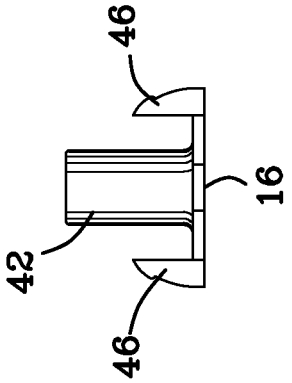


FIG. 4D

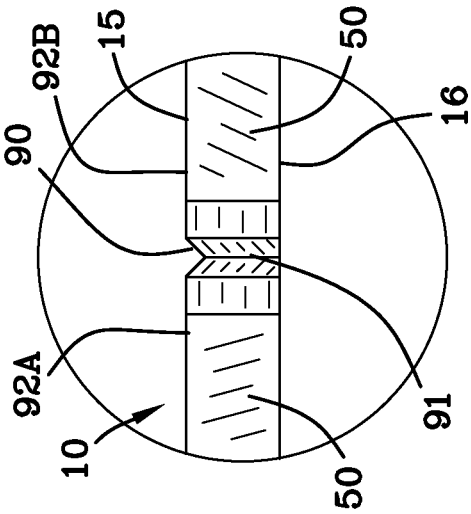


FIG. 4E

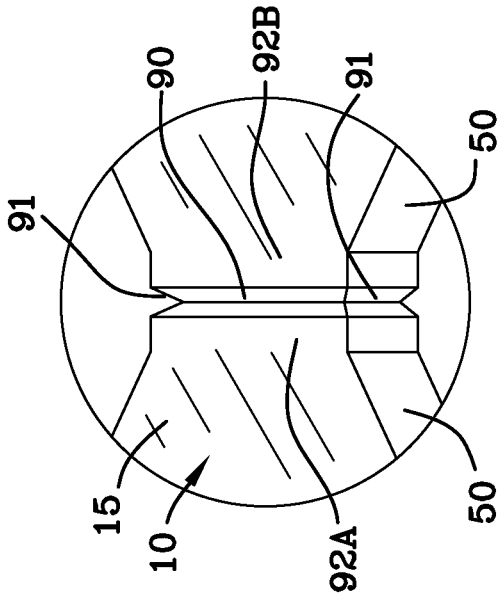


FIG. 4A

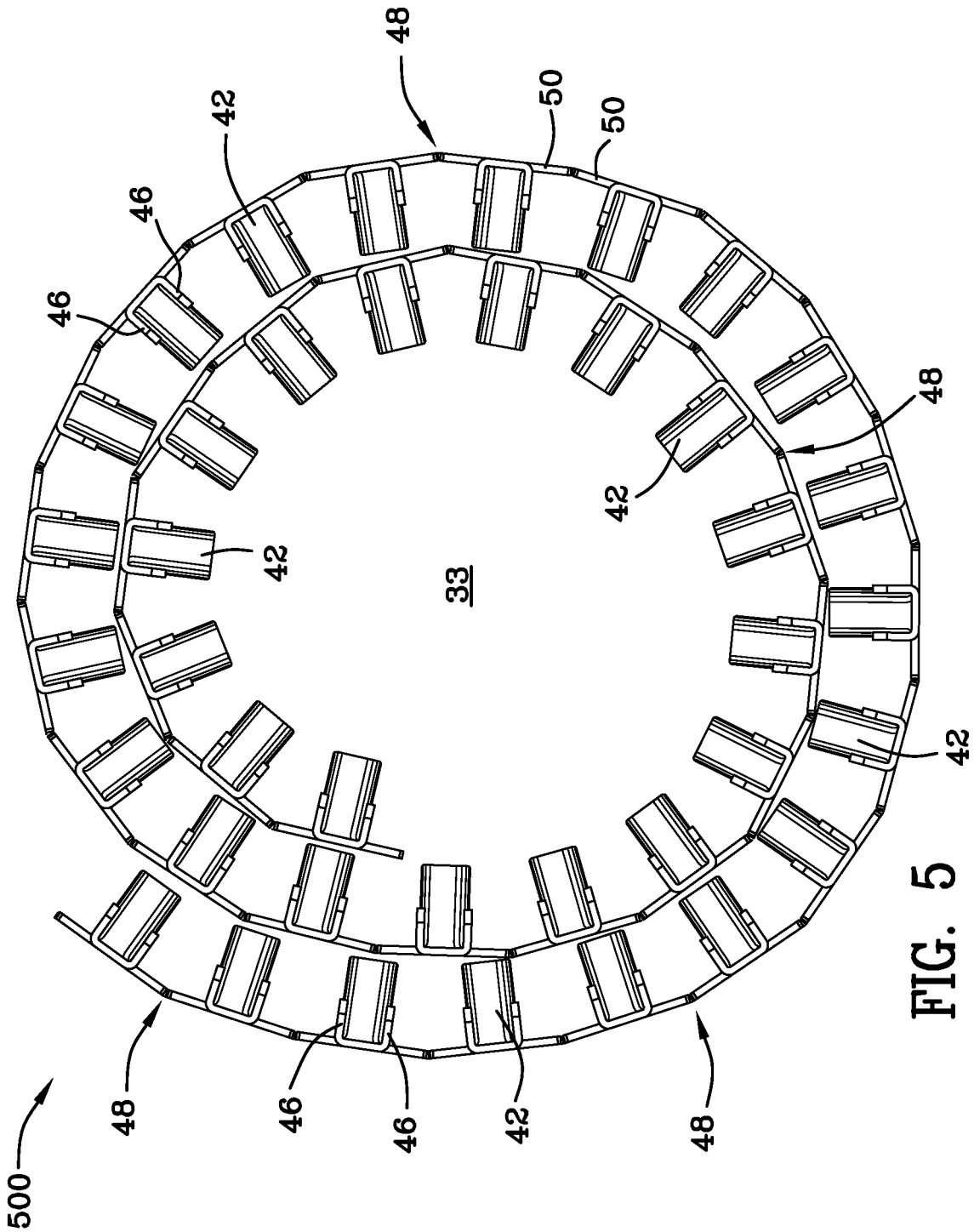


FIG. 5

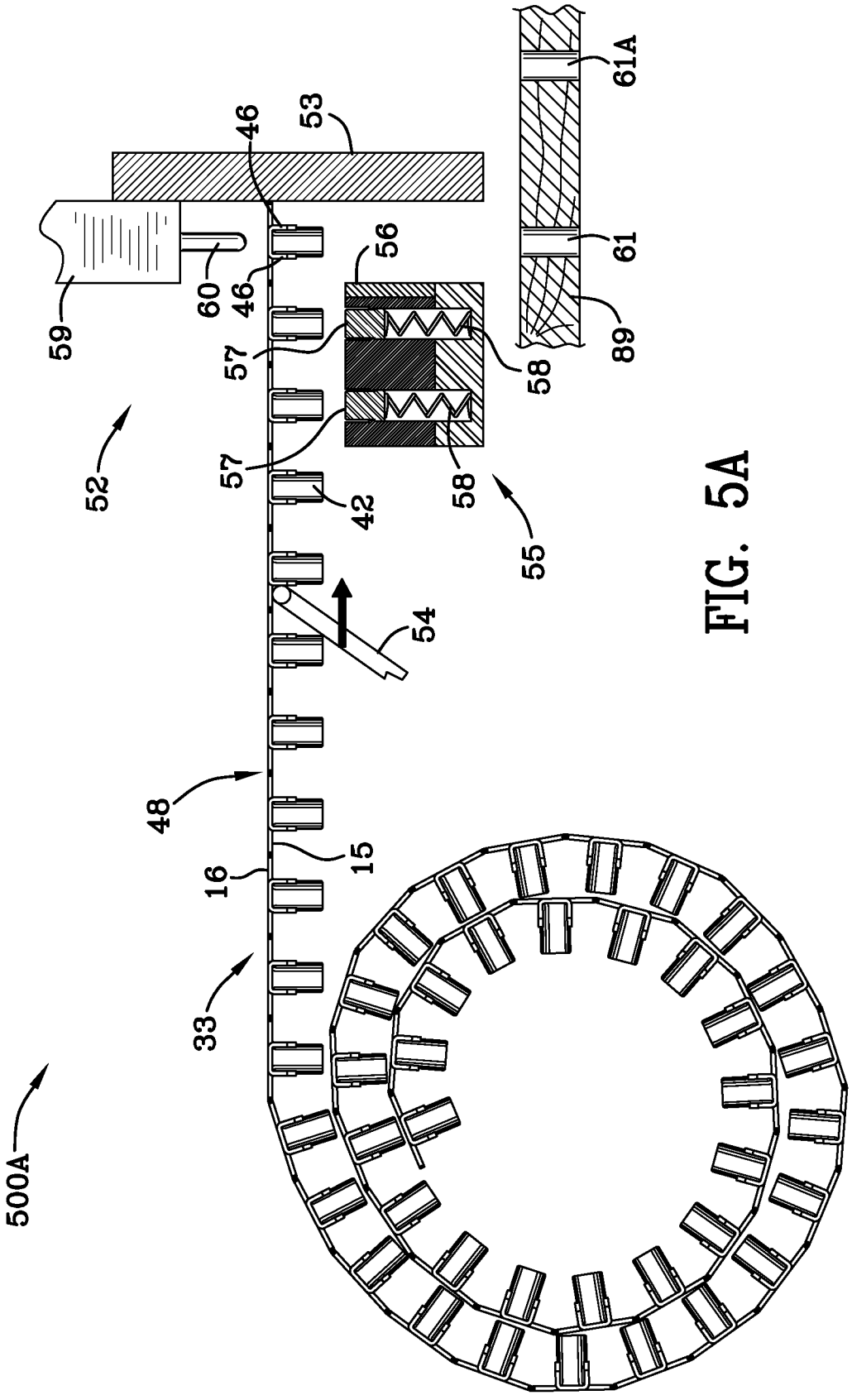


FIG. 5A

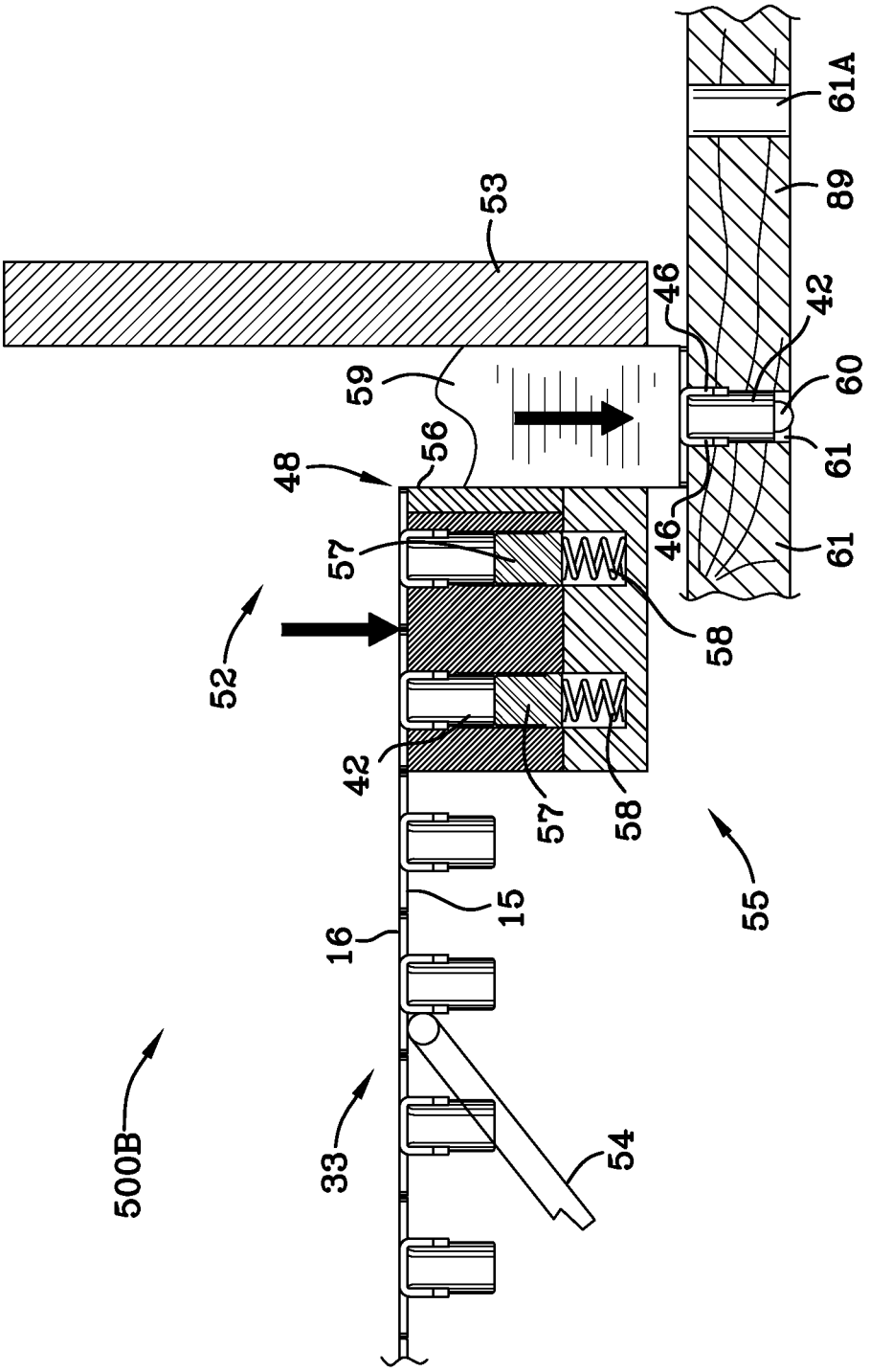

61A
89
53
46
42
59
60
56
61
48
46
61
57
58
52
42
57
58
55
15
16
500B
33
54

FIG. 5B

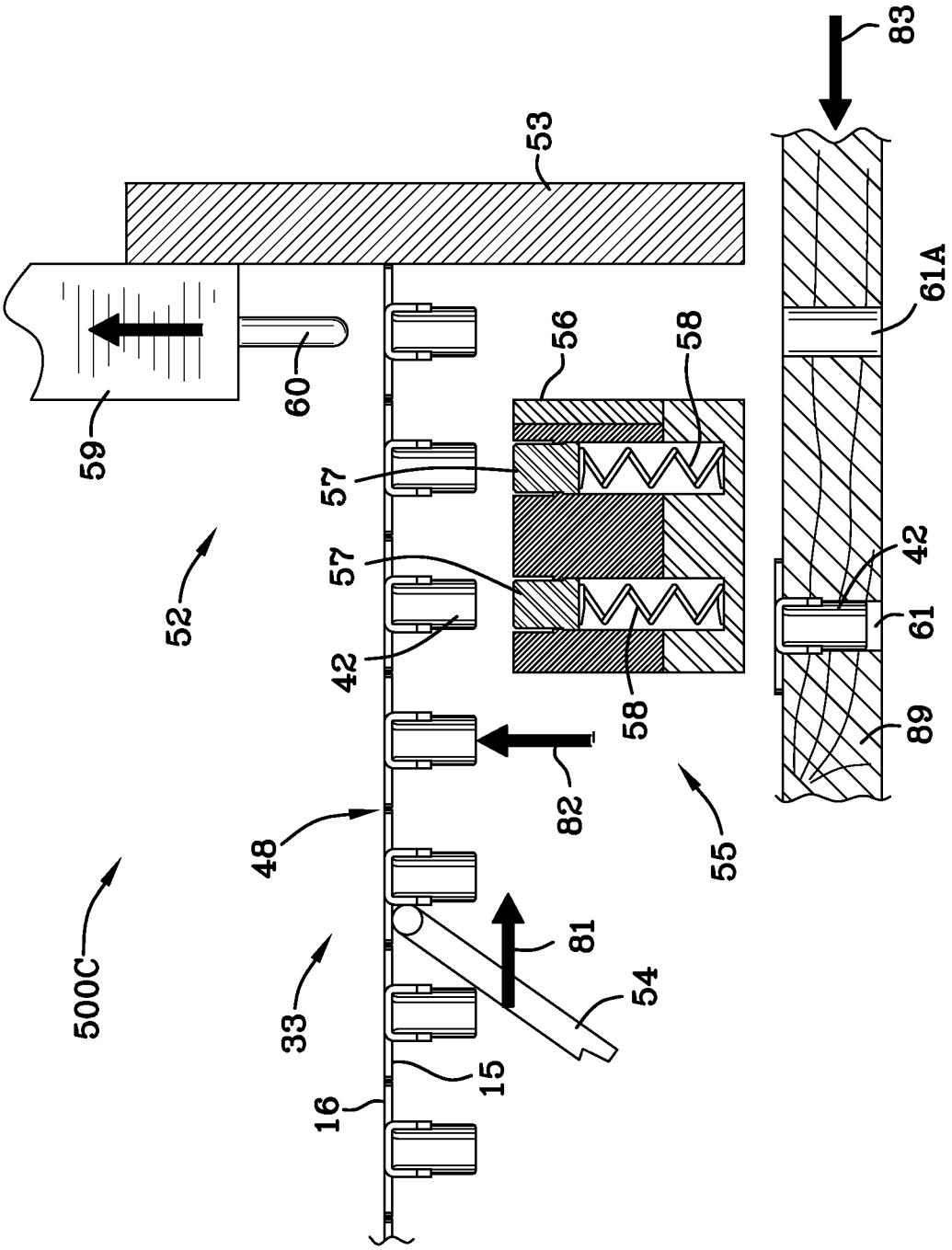

83
53
61A
56
58
60
59
57
57
42
52
42
61
89
58
82
48
55
500C
81
54
33
15
16

FIG. 5C

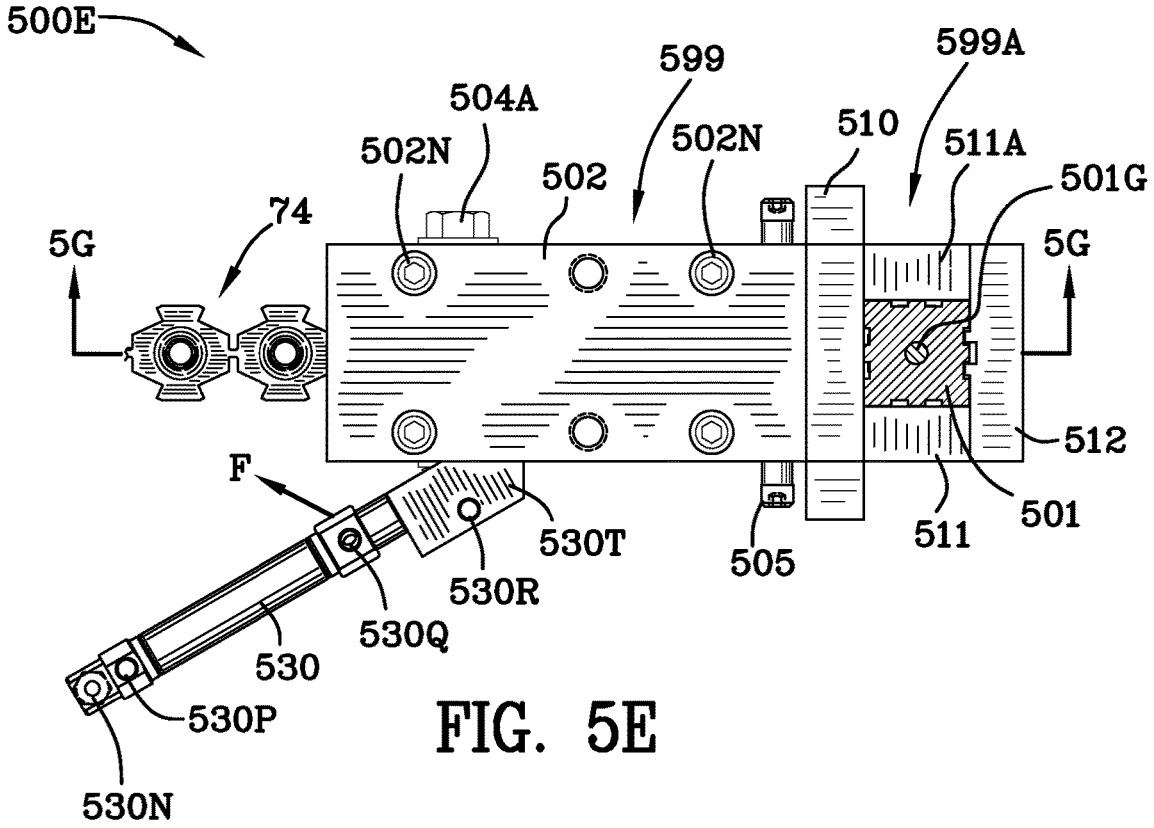

500E
599
599A
504A
502N
502N
502
510
511A
501G
74
5G
5G
512
F
530T
530R
530Q
530
530P
530N
505
511
501

FIG. 5E

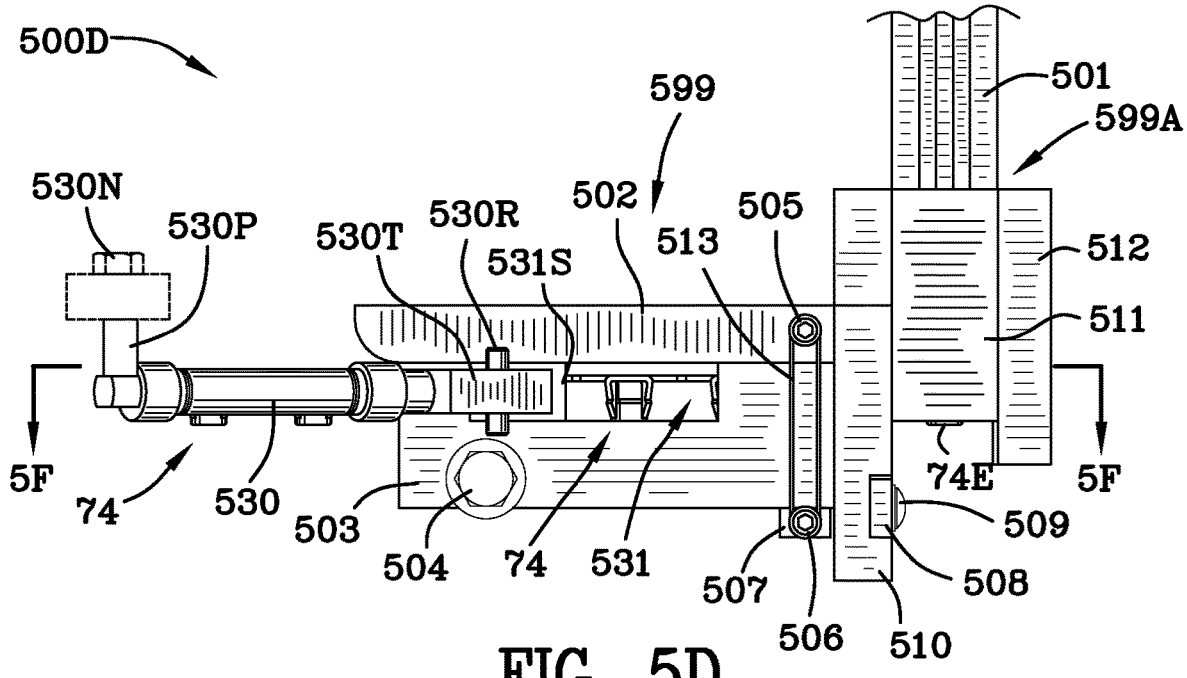

500D
501
599
599A
530N
530P
530T
530R
502
505
513
512
531S
511
5F
74
530
503
504
74
531
507
506
74E
5F
509
508
510

FIG. 5D

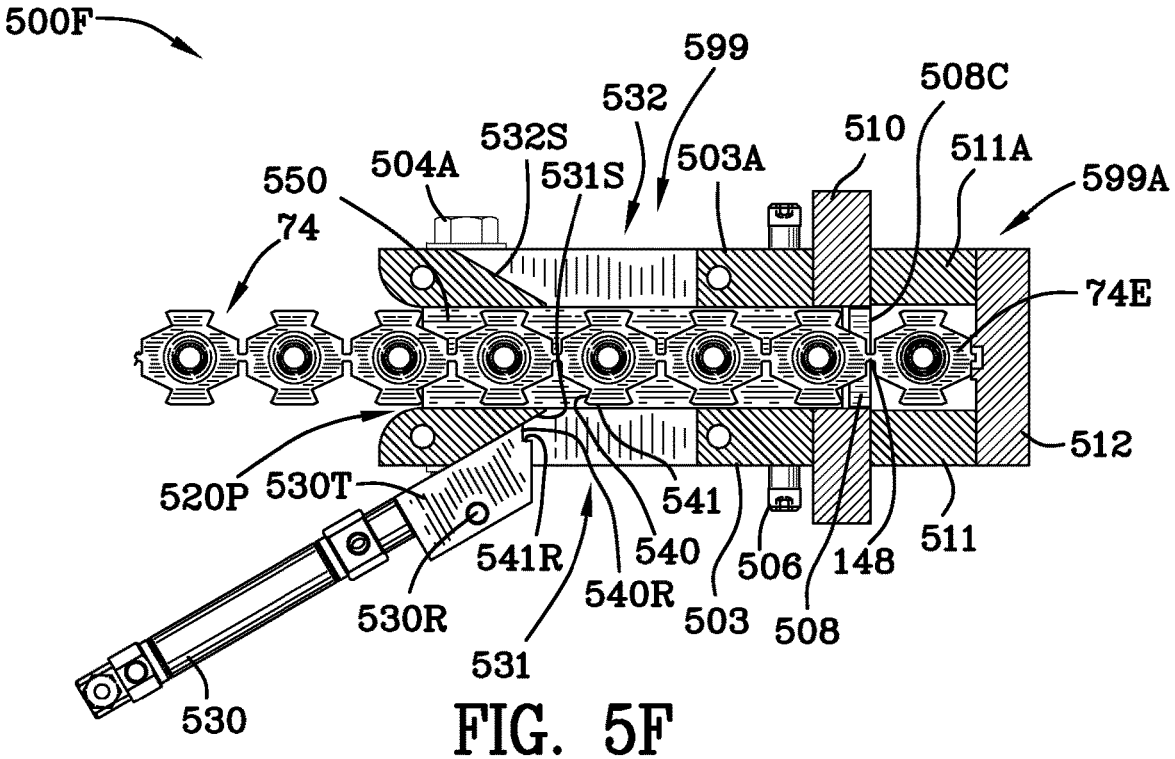

500F
599
532
508C
532S
504A
531S
503A
510
511A
599A
550
74
74E
512
520P
530T
541
541R
540
506
148
511
530R
540R
503
508
531
530

FIG. 5F

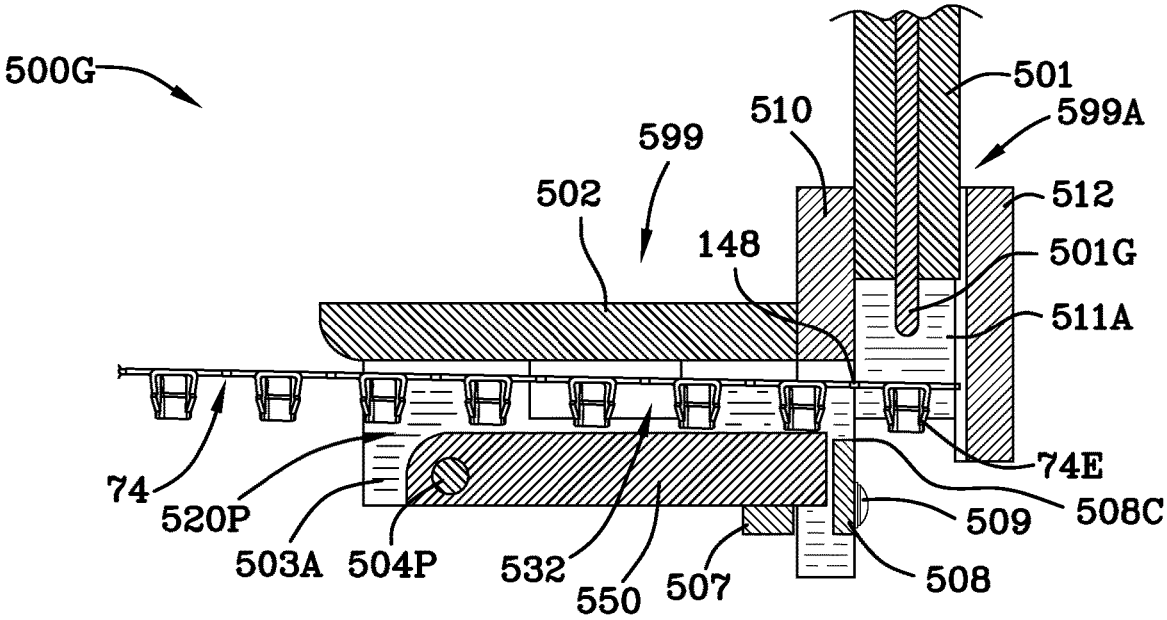

500G
501
510
599A
599
502
512
148
501G
511A
74E
74
520P
509
508C
503A
504P
532
550
507
508

FIG. 5G

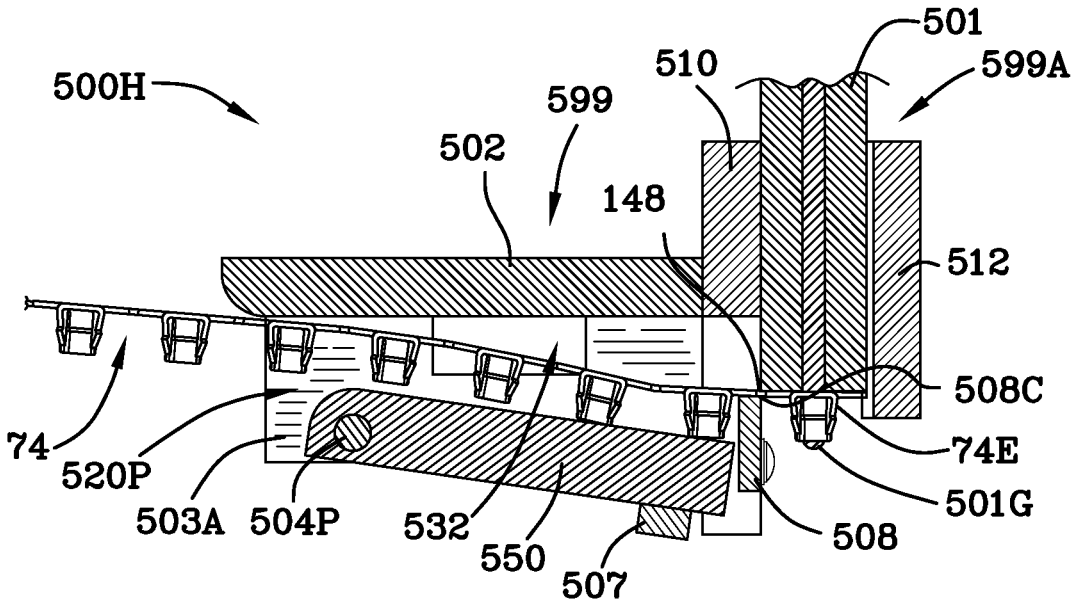

500H
501
510
599A
599
502
148
512
508C
74E
501G
74
520P
503A
504P
532
550
507
508

FIG. 5H

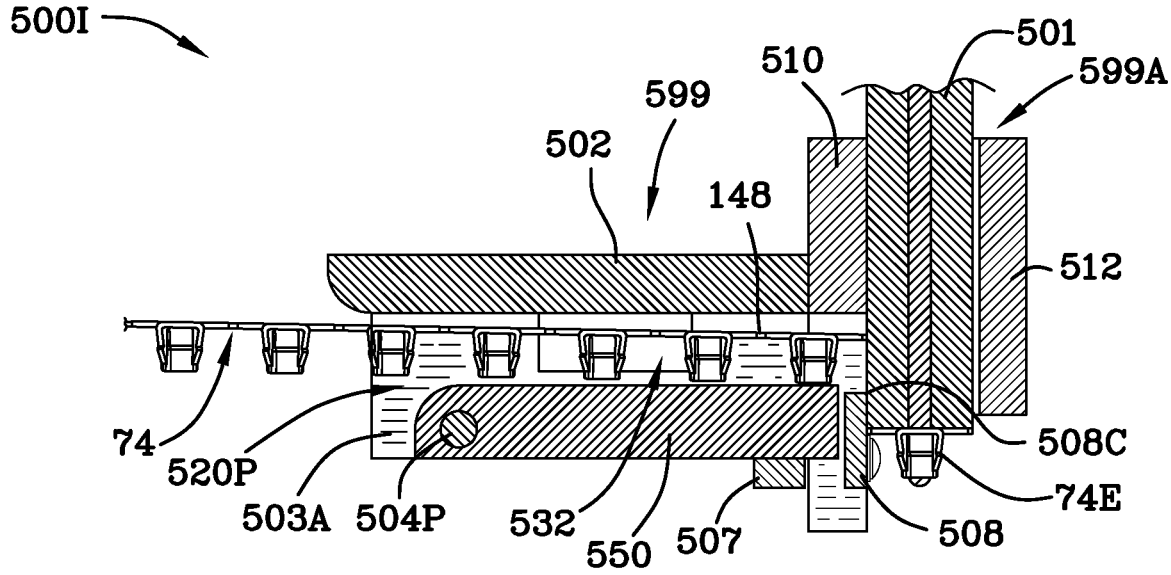

500I
501
510
599A
599
502
148
512
508C
74E
74
520P
503A
504P
532
550
507
508

FIG. 5I

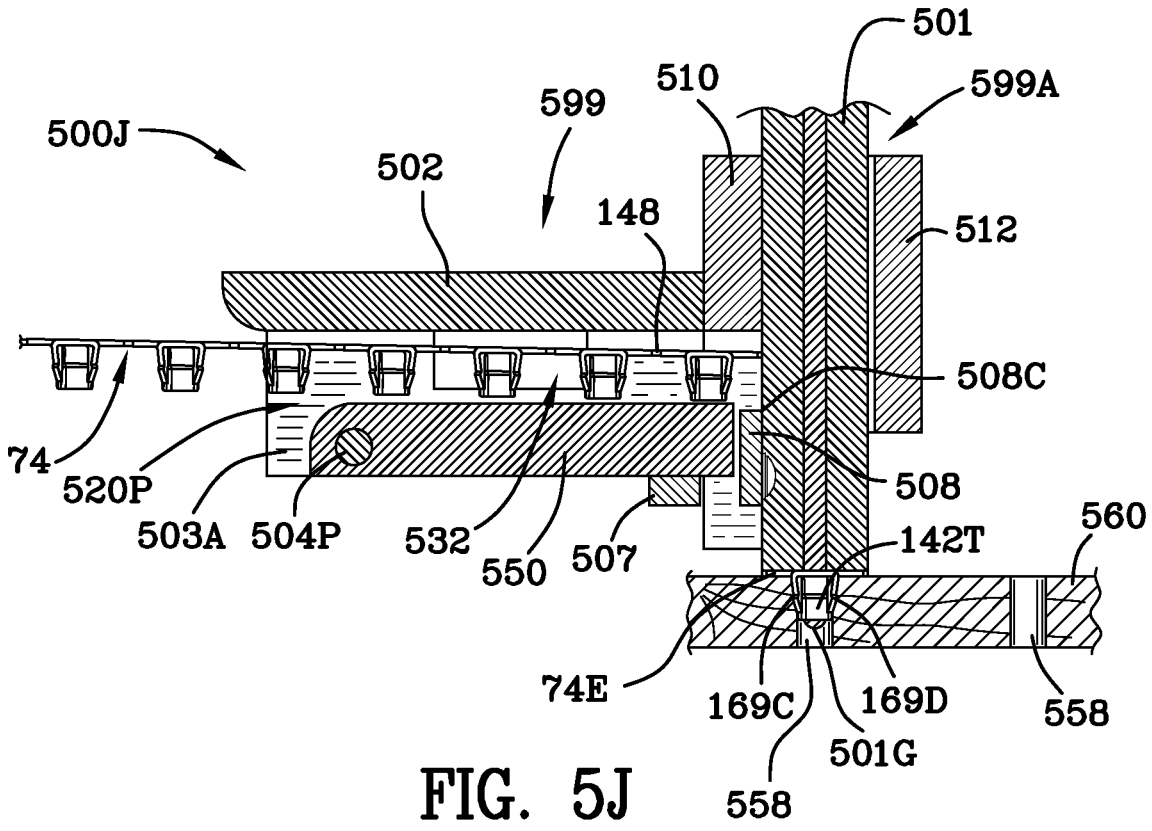

501
599A
510
599
500J
502
148
512
508C
74
520P
503A
504P
532
550
507
508
560
142T
74E
169C
169D
558
501G
558

FIG. 5J

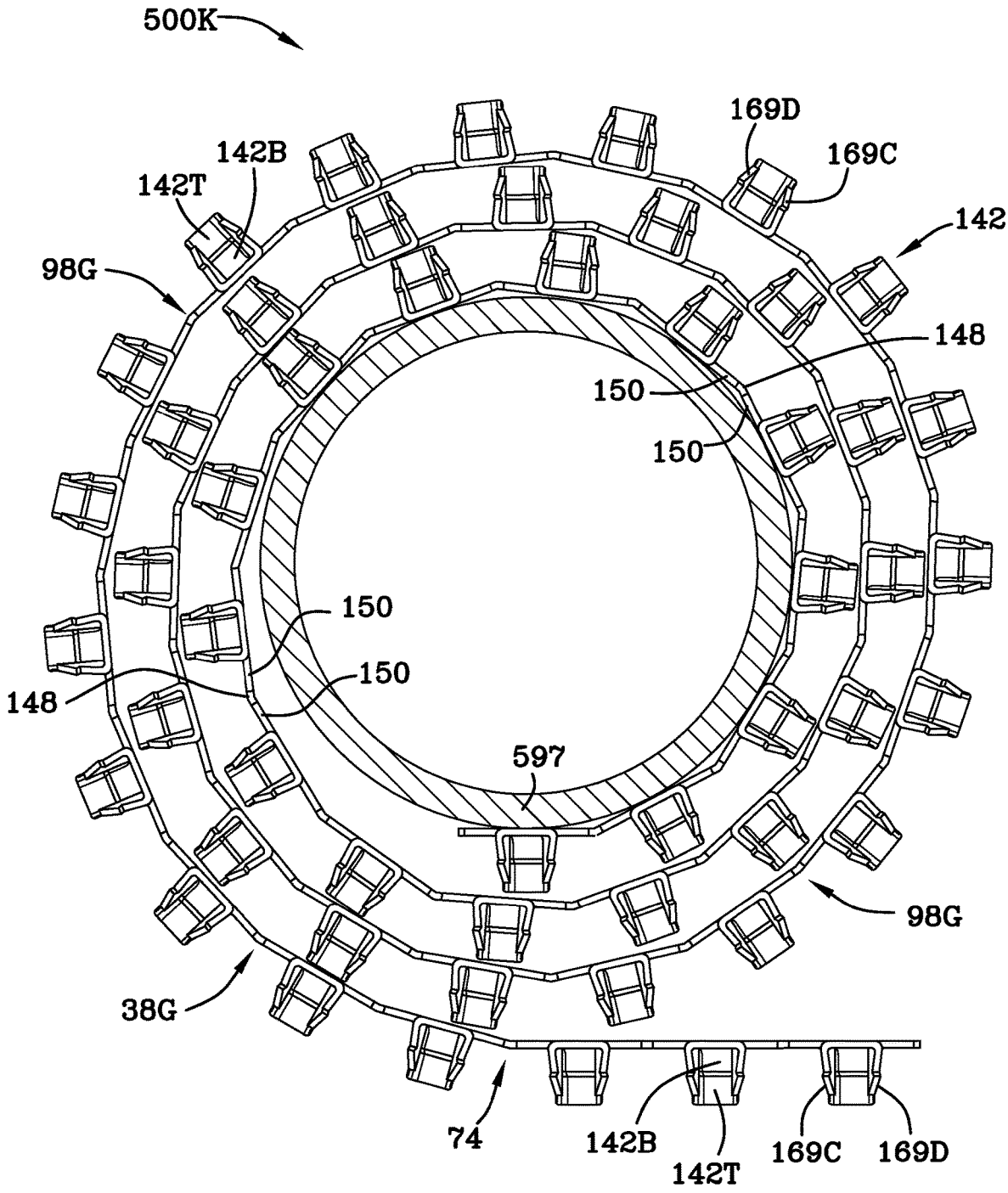

500K
169D
142B
169C
142T
142
98G
148
150
150
150
148
150
597
98G
38G
74
142B
142T
169C
169D

FIG. 5K

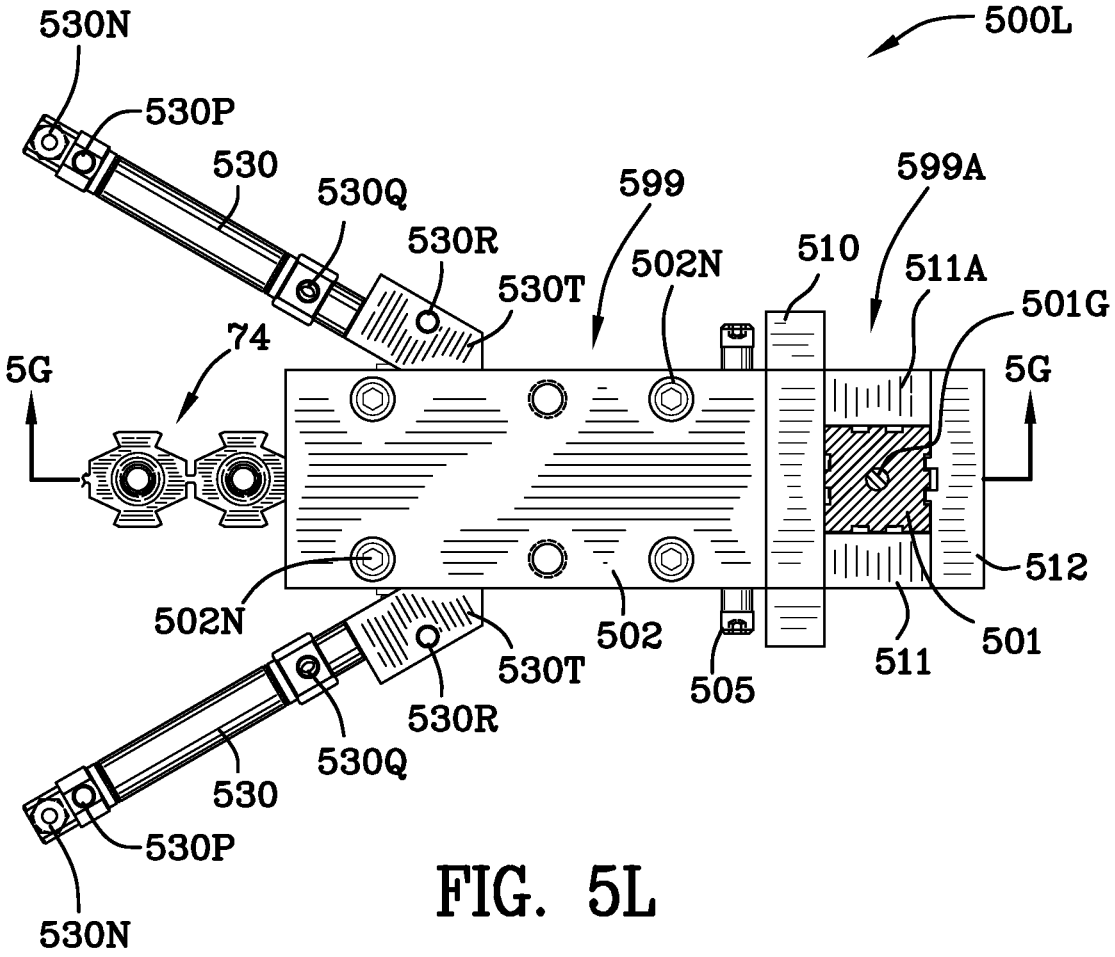

530N
500L
530P
530
530Q
599
599A
530R
530T
502N
510
511A
501G
74
5G
5G
512
502N
502
530T
505
511
501
530R
530Q
530
530P
530N

FIG. 5L

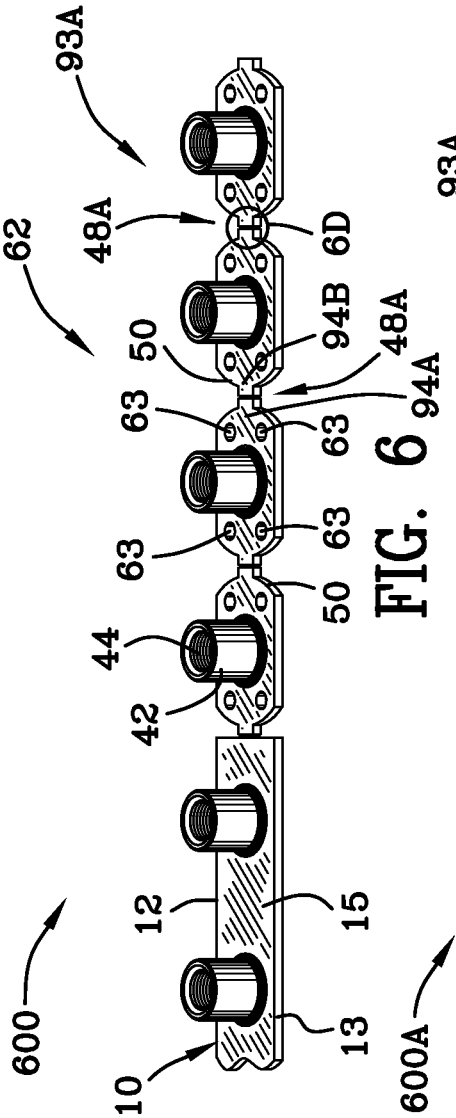


FIG. 6

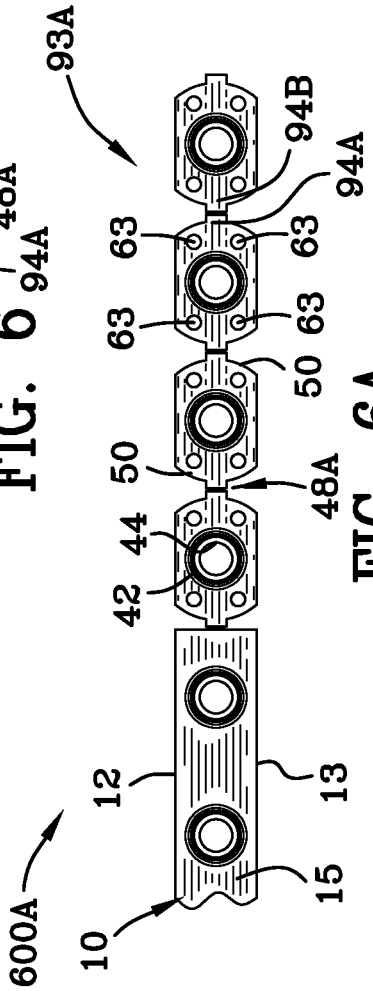


FIG. 6A

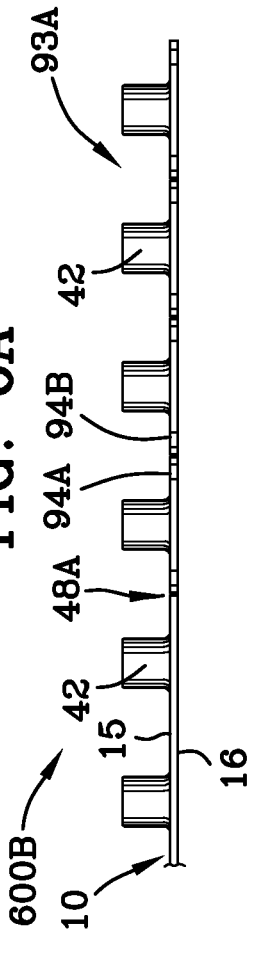


FIG. 6B

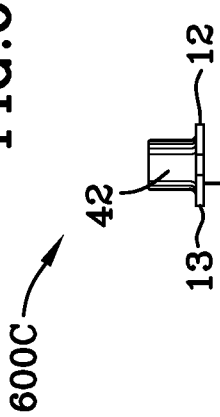


FIG.6C

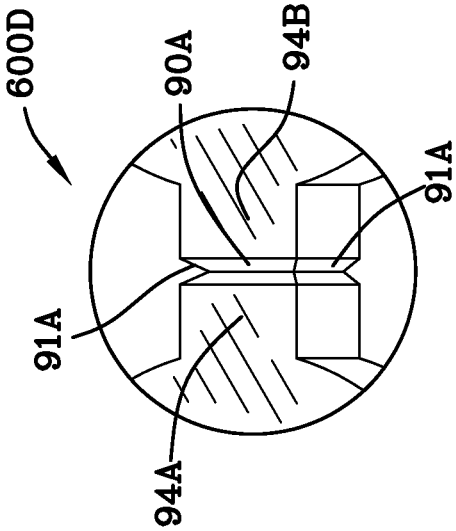
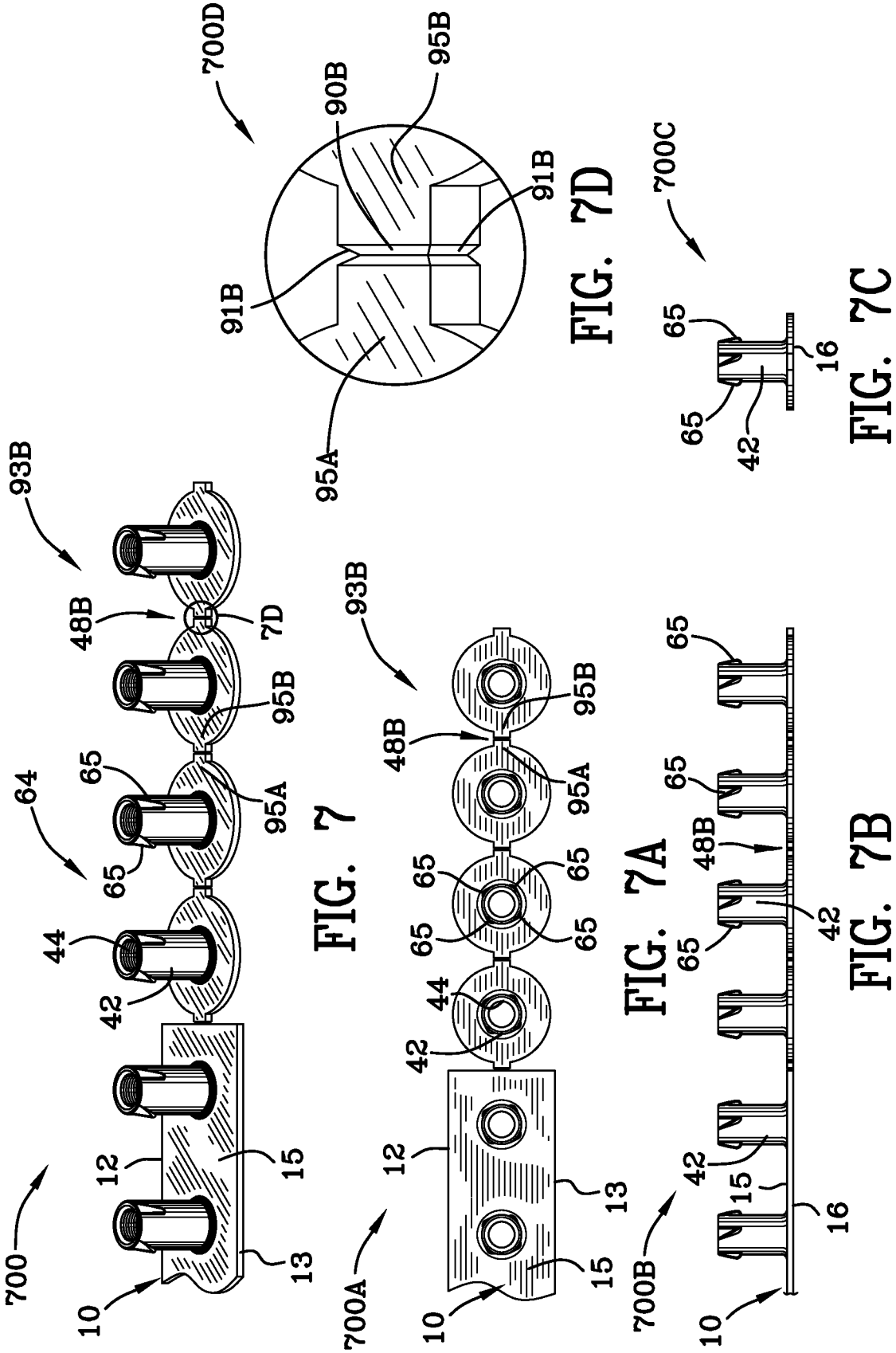


FIG.6D


700D
90B
95B
91B
91B
95A
93B
48B
7D
95B
64
65
95A
65
44
42
700
12
15
13
10
FIG. 7D
700C
65
16
65
42
FIG. 7C
93B
48B
95B
95A
65
65
65
65
44
42
12
13
15
700A
10
FIG. 7
65
48B
65
42
65
42
15
16
700B
10
FIG. 7A
FIG. 7B

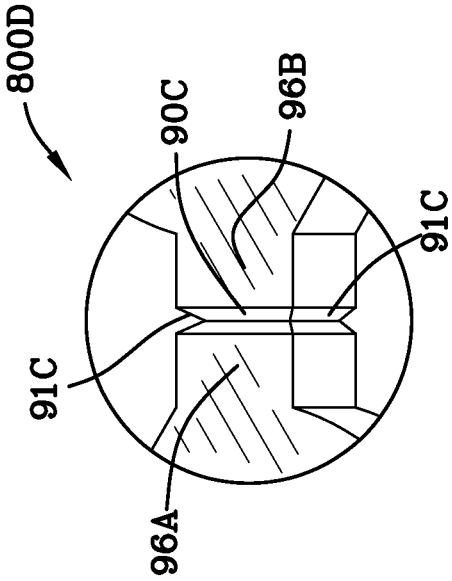


FIG. 8D

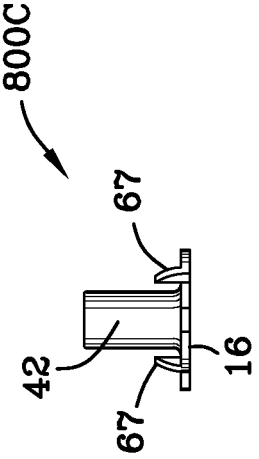


FIG. 8C

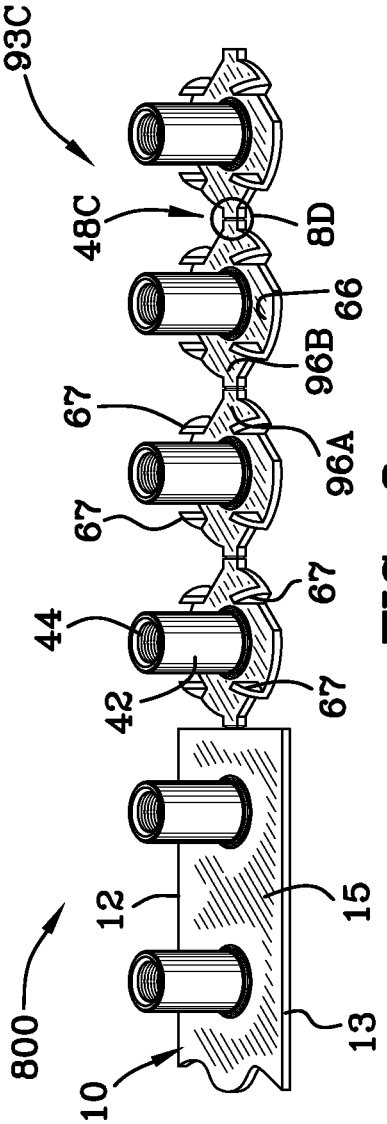


FIG. 8

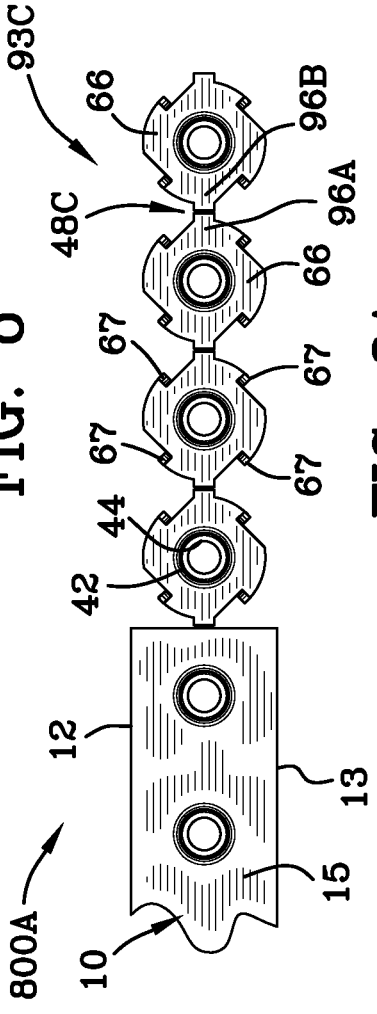


FIG. 8A

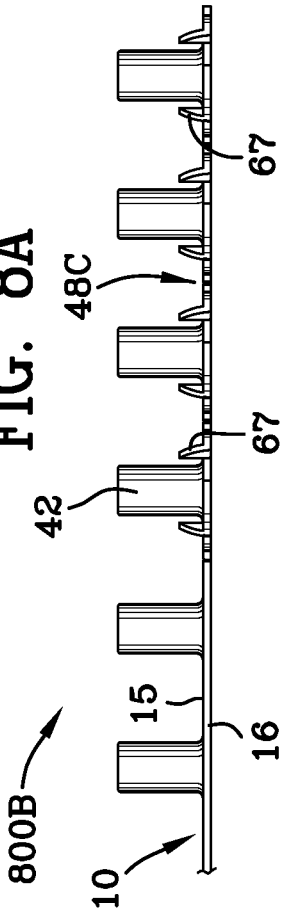


FIG. 8B

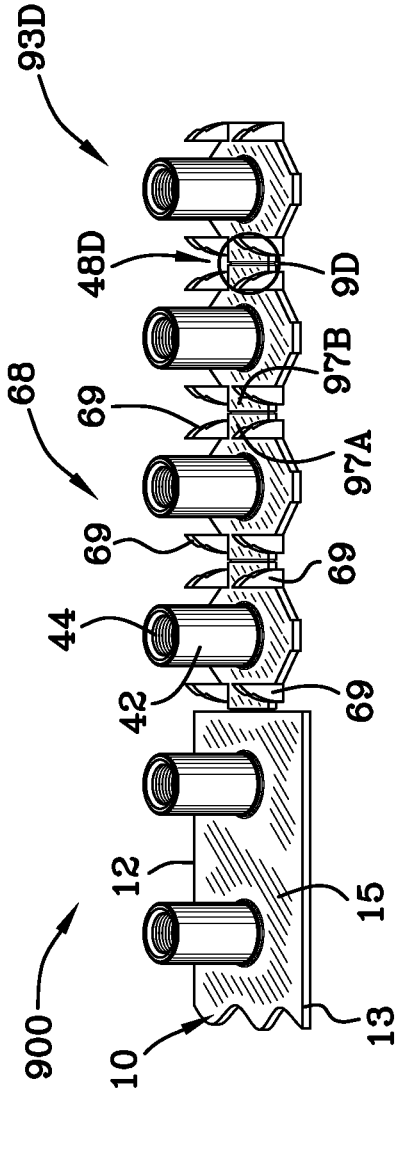


FIG. 9

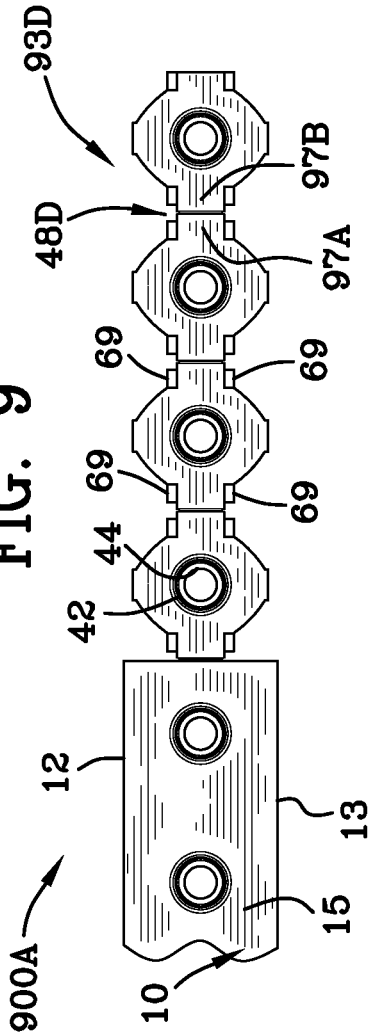


FIG. 9A

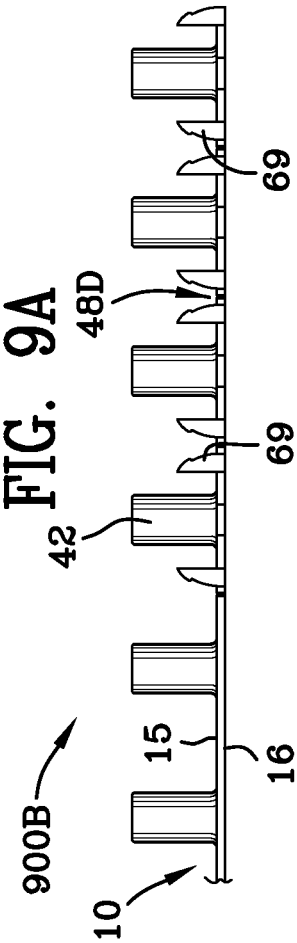


FIG. 9B

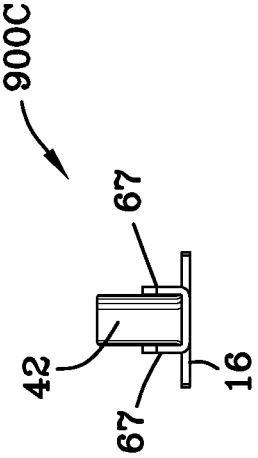


FIG. 9C

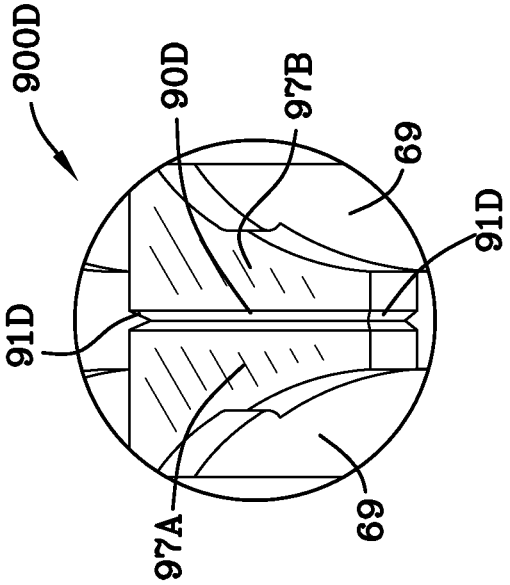


FIG. 9D

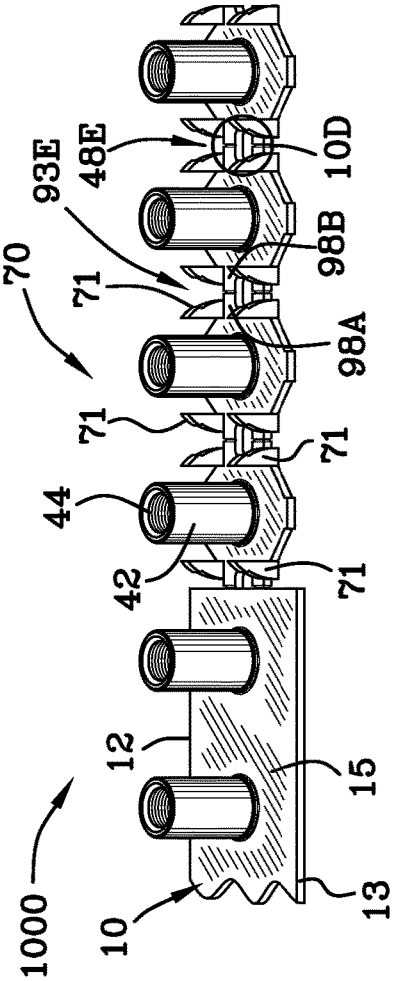


FIG. 10

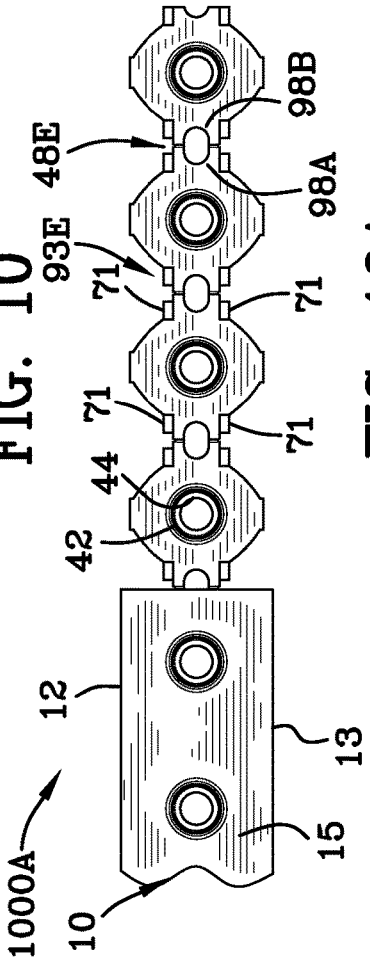


FIG. 10A

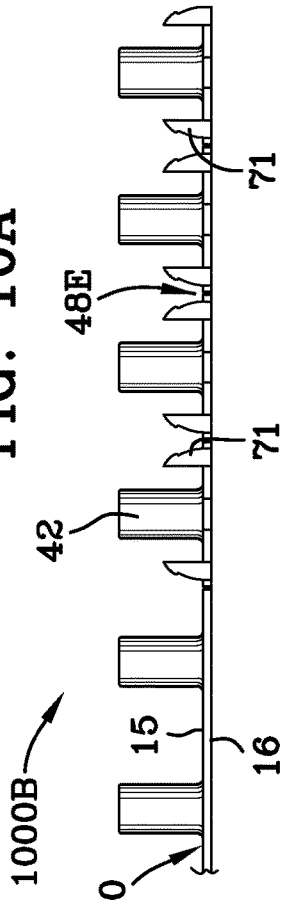


FIG. 10B

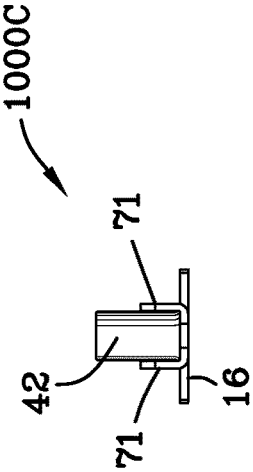


FIG. 10C

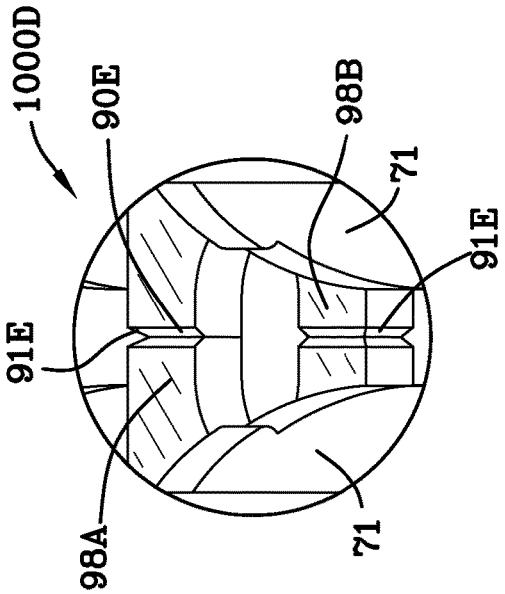


FIG. 10D

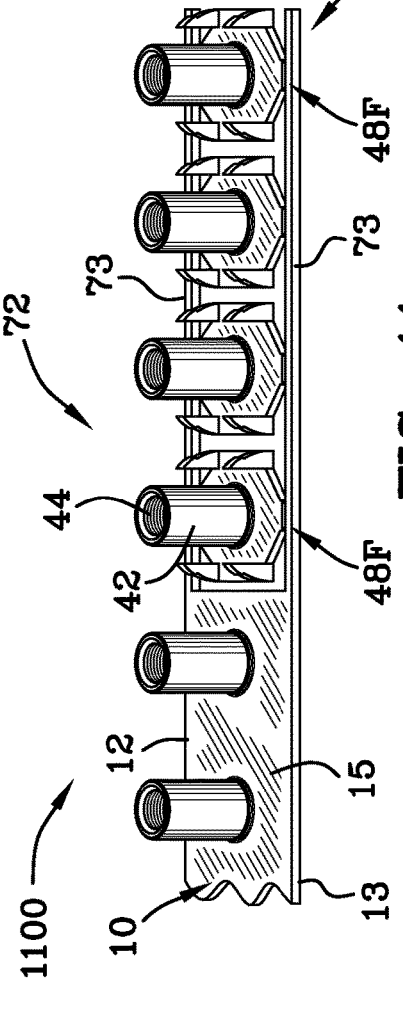


FIG. 11

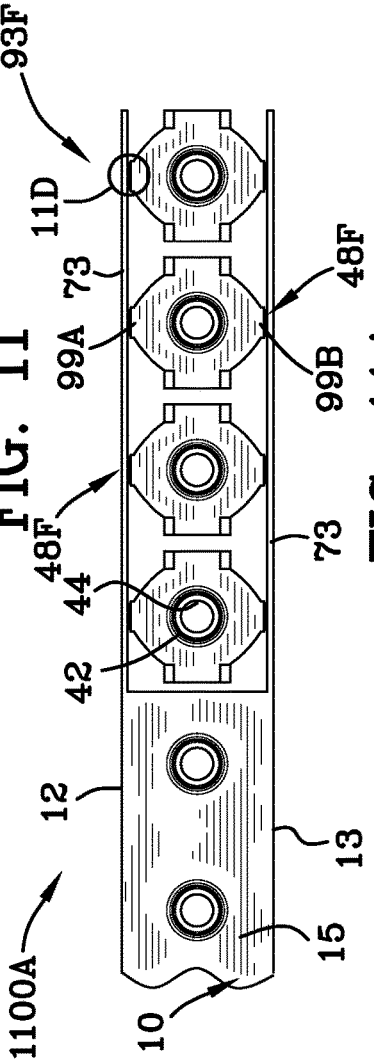


FIG. 11A

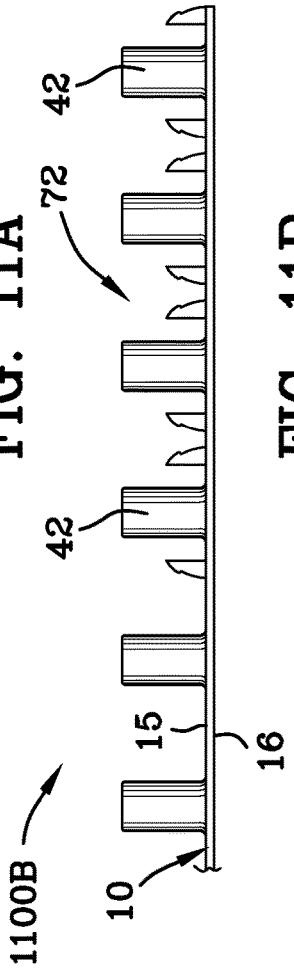


FIG. 11B

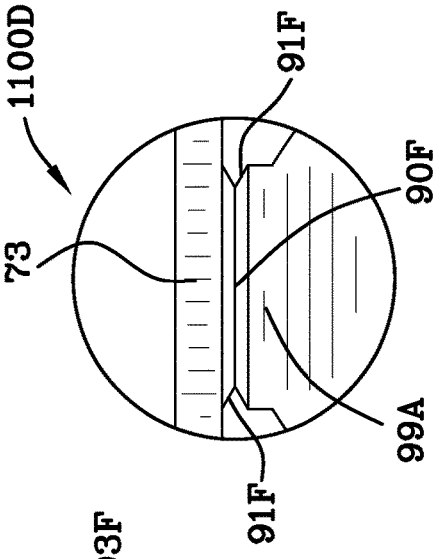


FIG. 11D

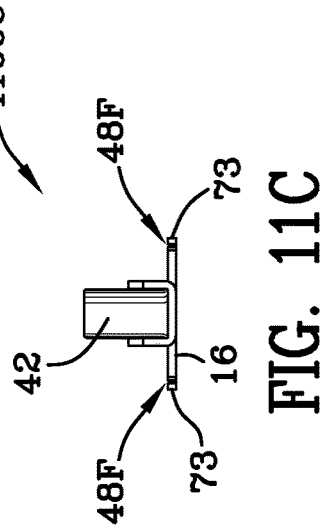


FIG. 11C

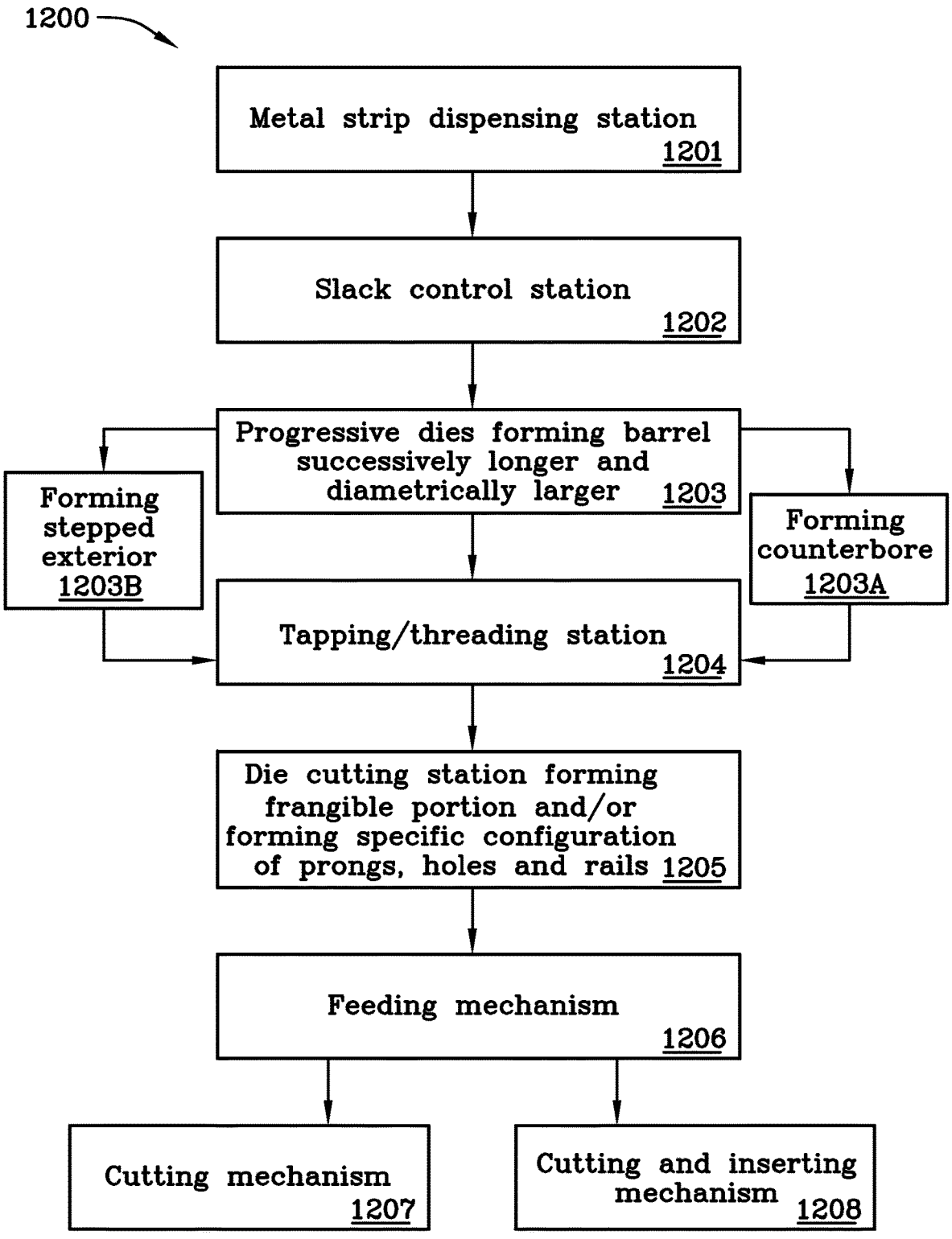

1200
Metal strip dispensing station 1201
Slack control station 1202
Progressive dies forming barrel successively longer and diametrically larger 1203
Forming stepped exterior 1203B
Forming counterbore 1203A
Tapping/threading station 1204
Die cutting station forming frangible portion and/or forming specific configuration of prongs, holes and rails 1205
Feeding mechanism 1206
Cutting mechanism 1207
Cutting and inserting mechanism 1208

FIG. 12

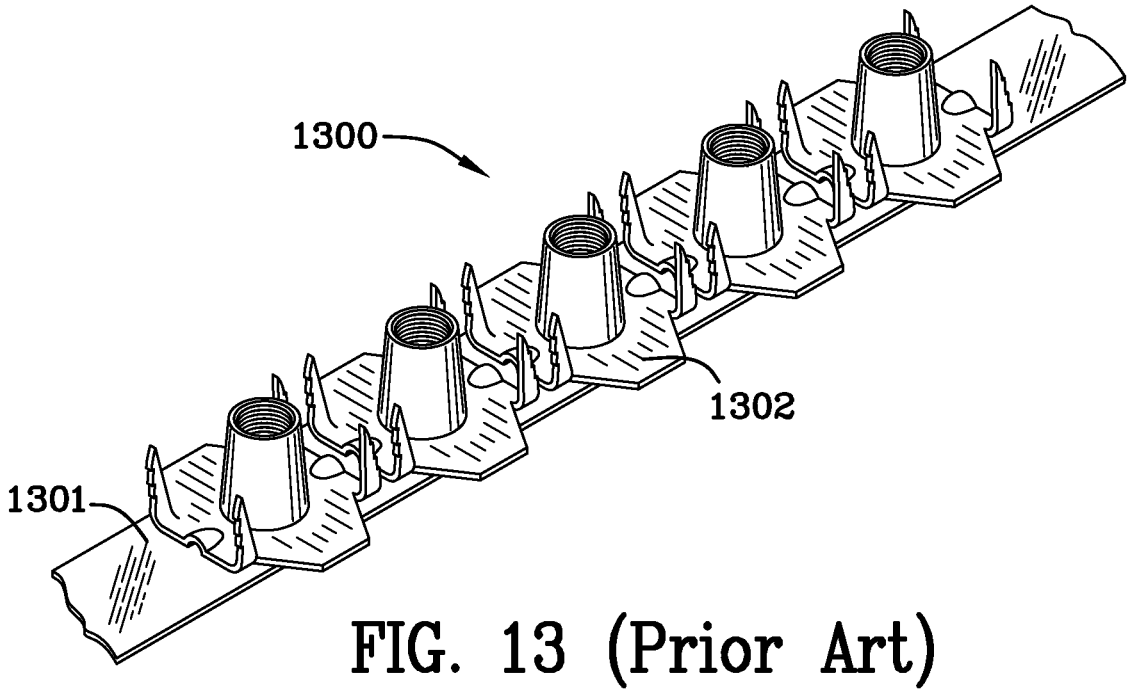


FIG. 13 (Prior Art)

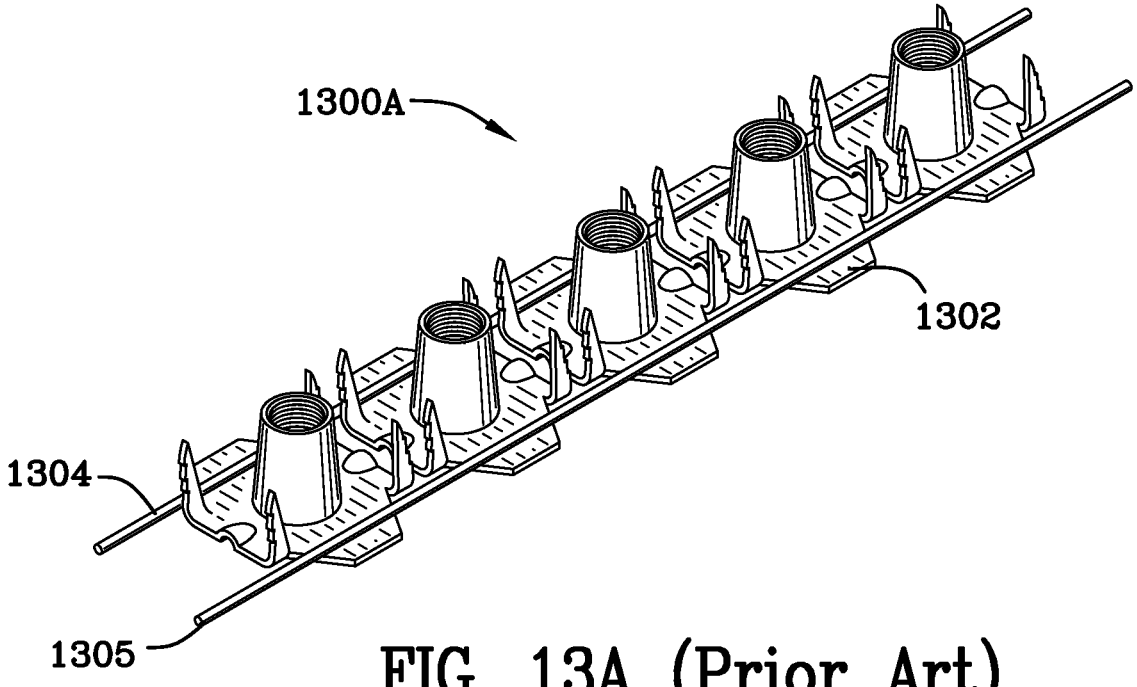


FIG. 13A (Prior Art)

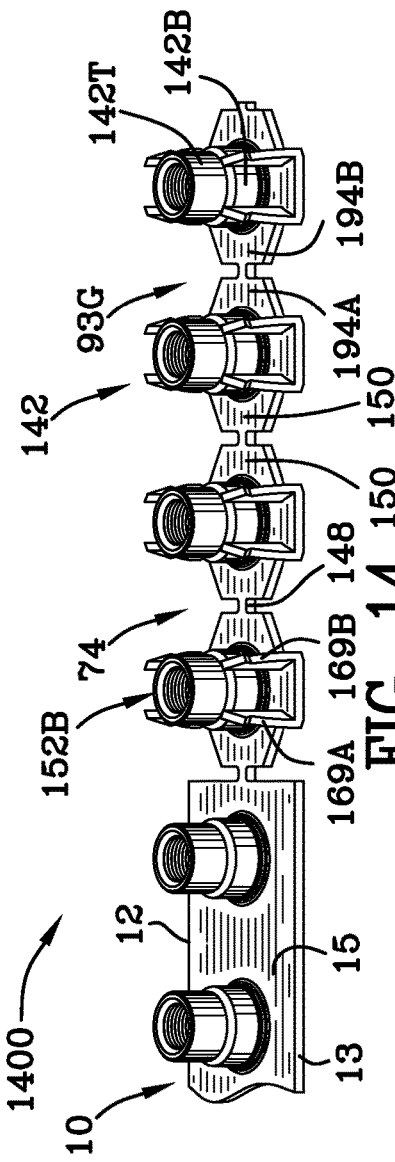


FIG. 14

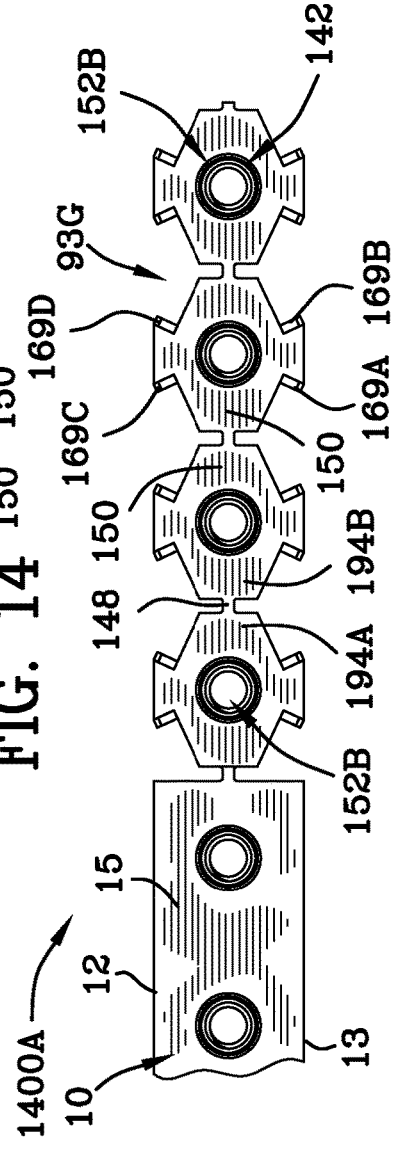


FIG. 14A

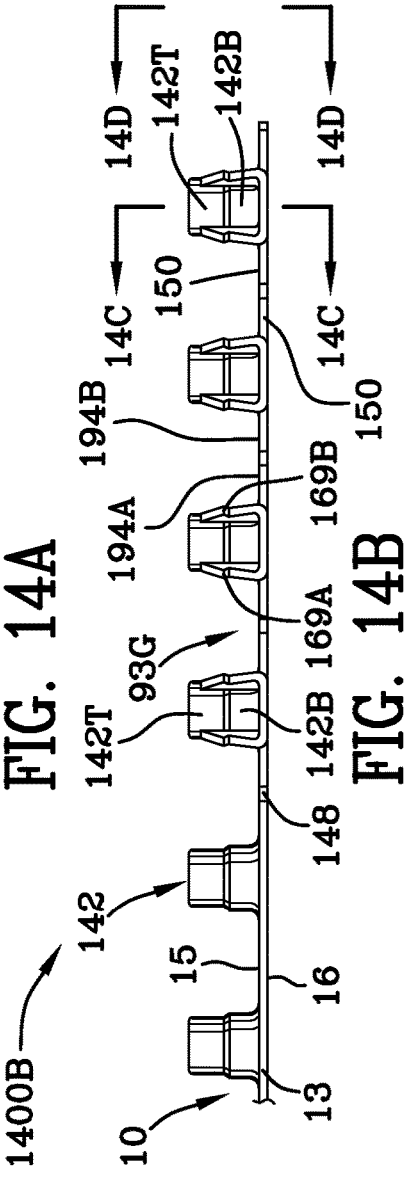


FIG. 14B

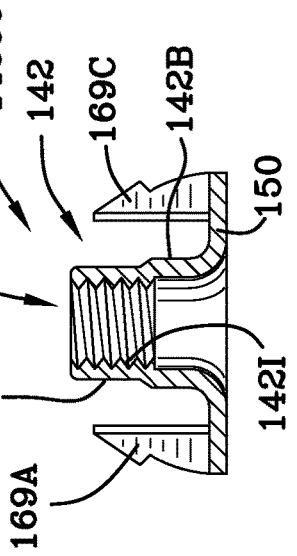


FIG. 14C

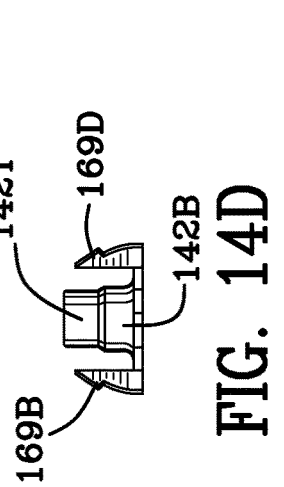


FIG. 14D

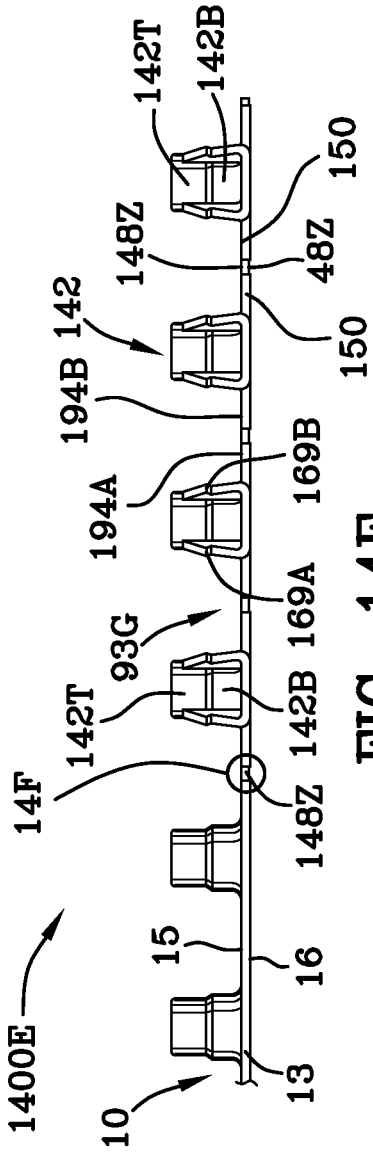


FIG. 14E

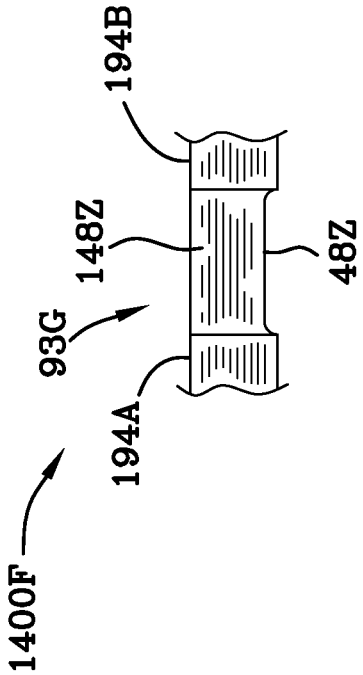


FIG. 14F

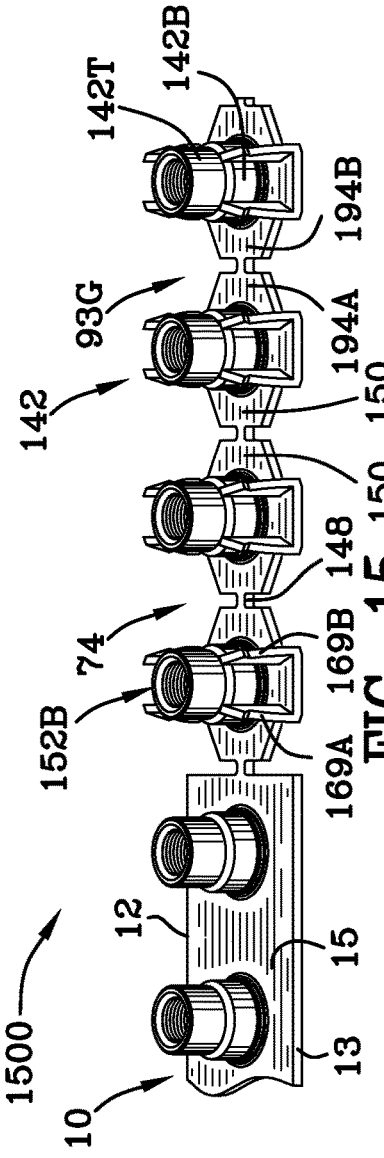


FIG. 15

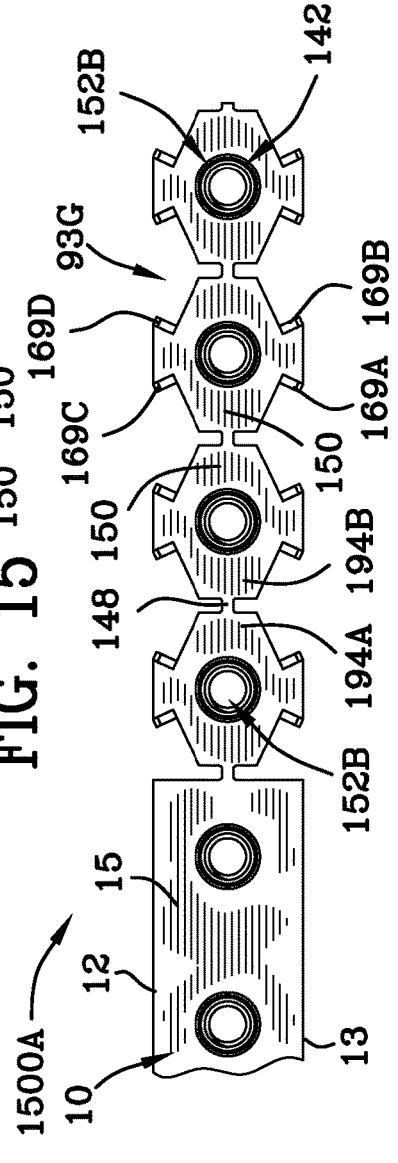


FIG. 15A

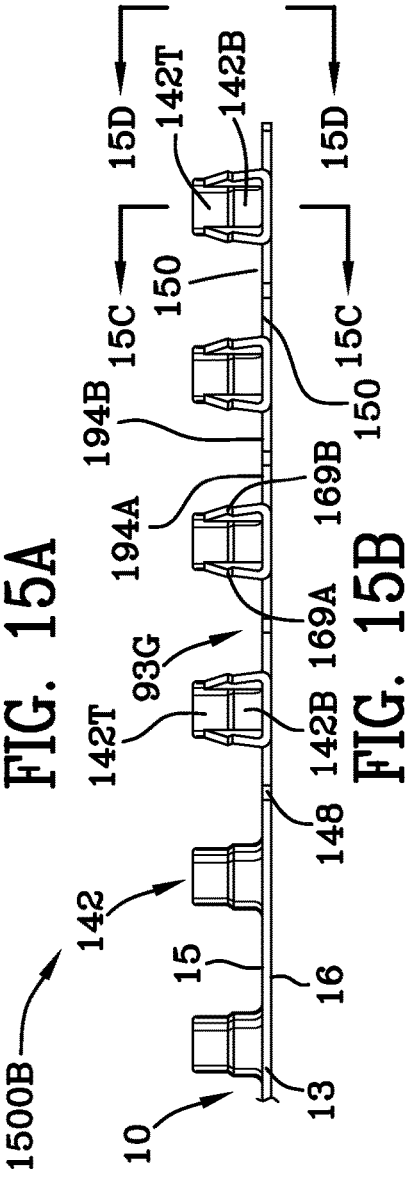


FIG. 15B

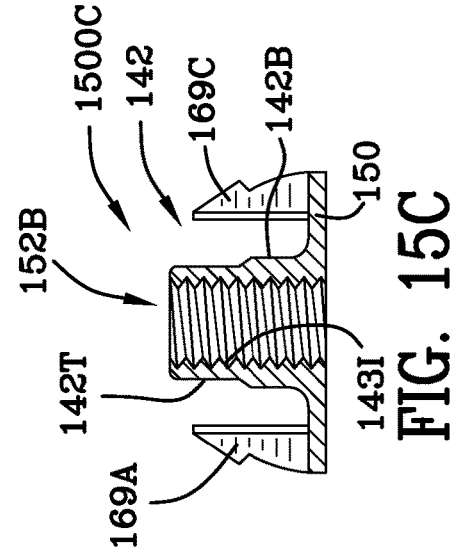


FIG. 15C

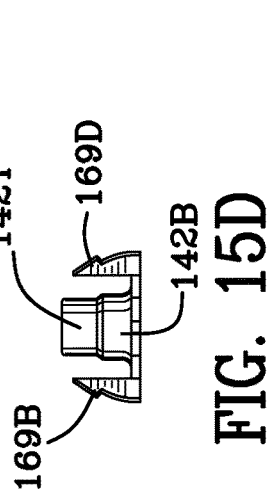


FIG. 15D

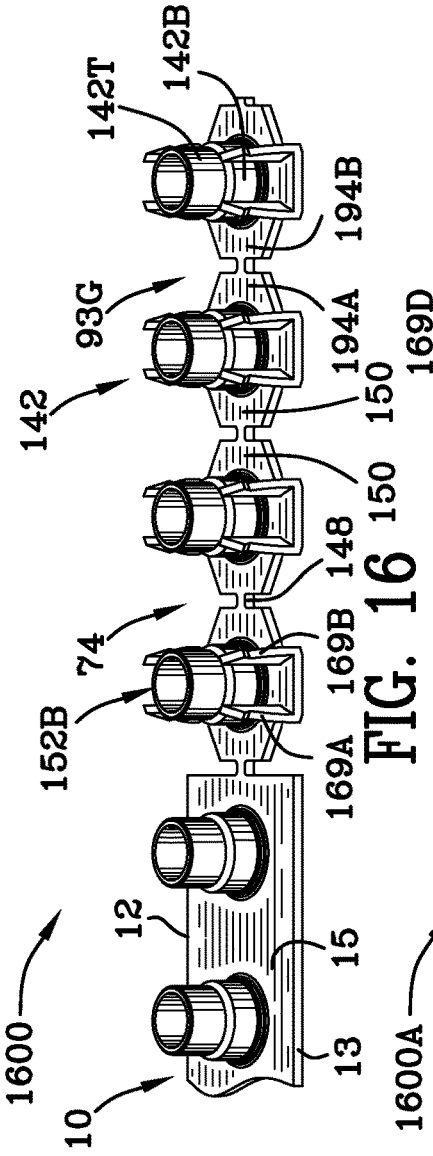


FIG. 16

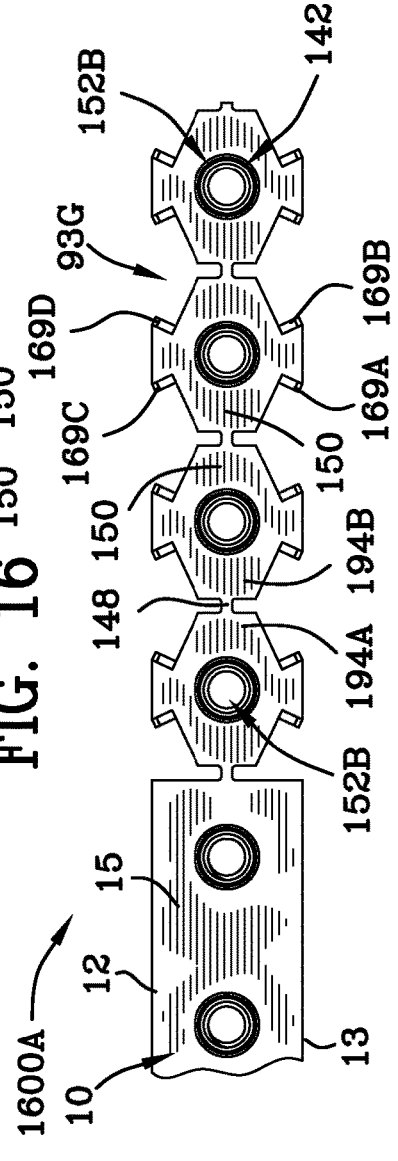


FIG. 16A

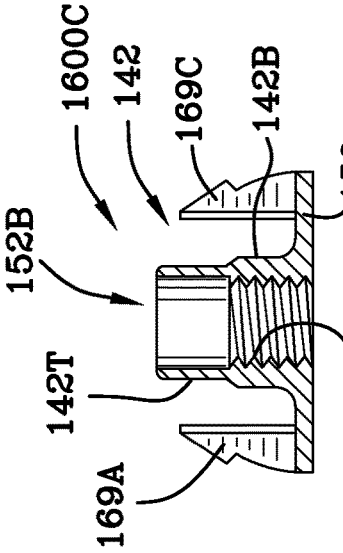


FIG. 16C

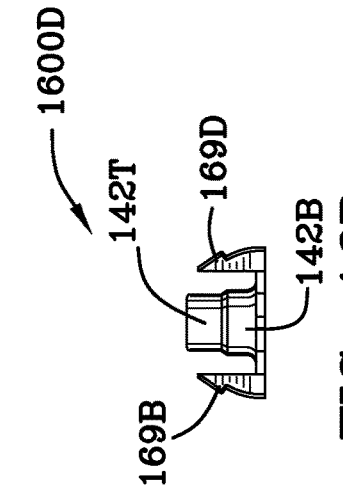


FIG. 16D

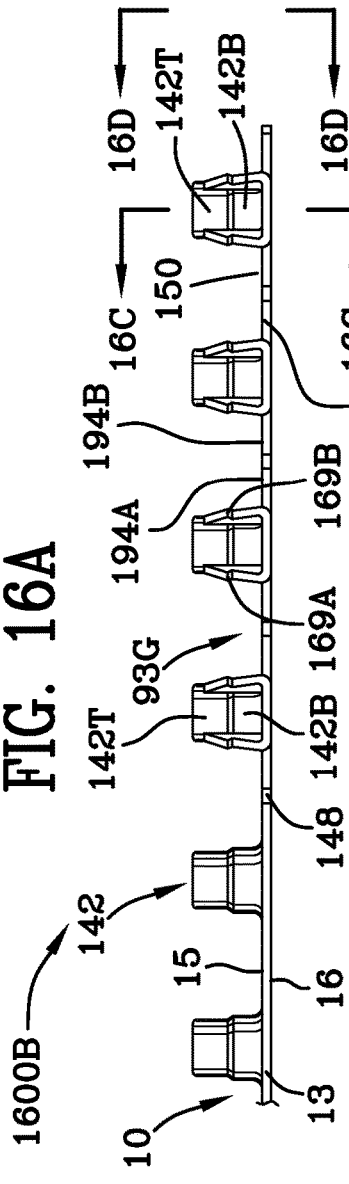


FIG. 16B

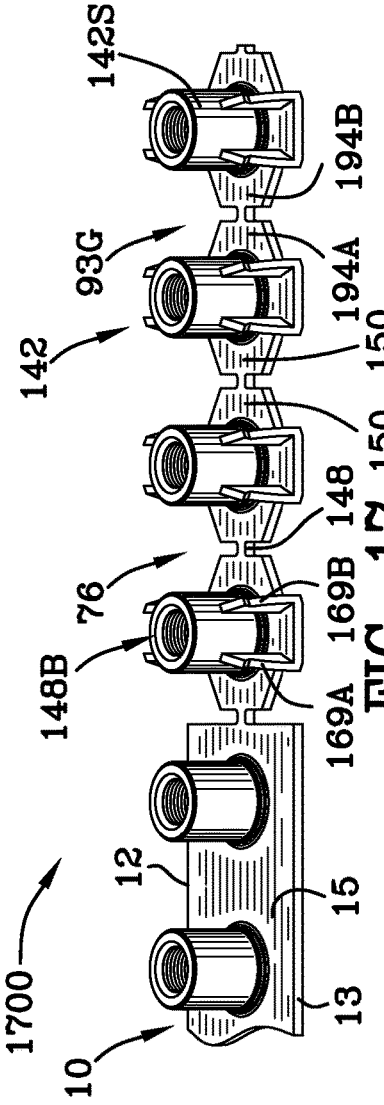


FIG. 17

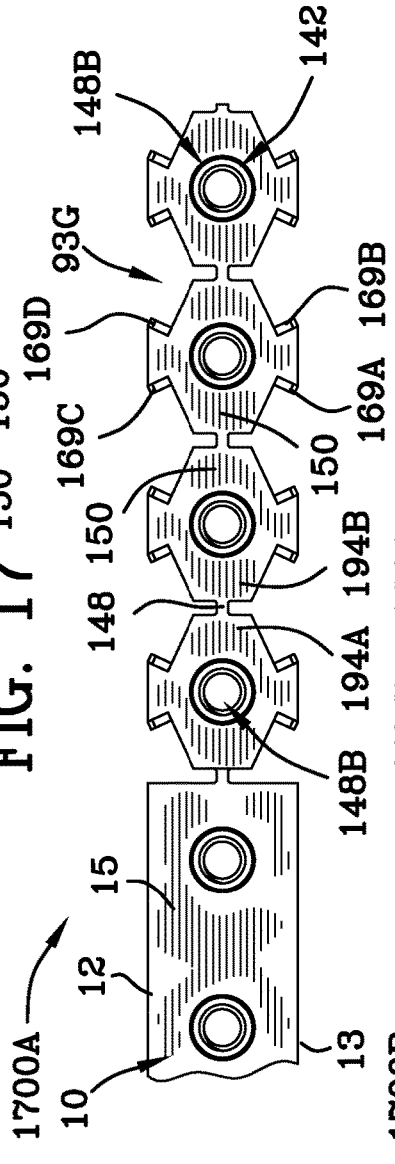


FIG. 17A

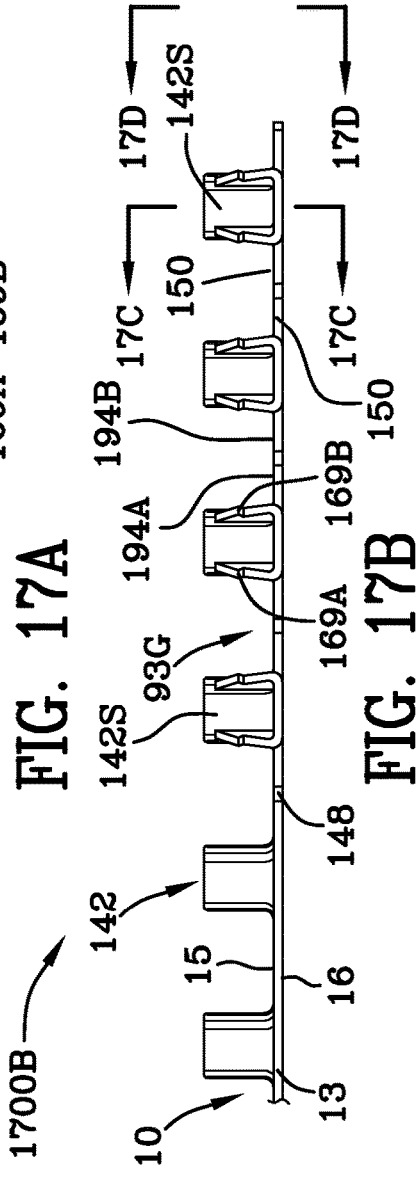


FIG. 17B

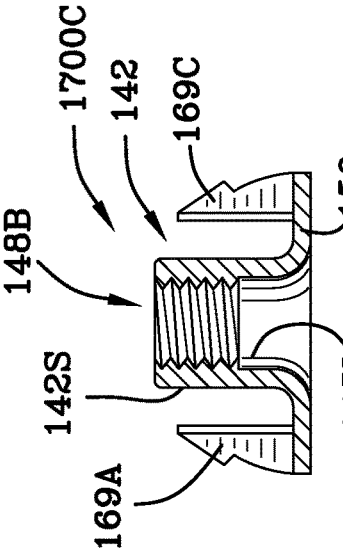


FIG. 17C

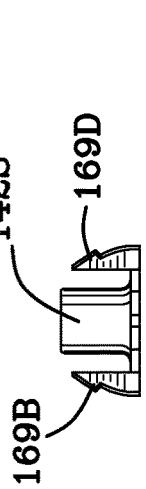


FIG. 17D

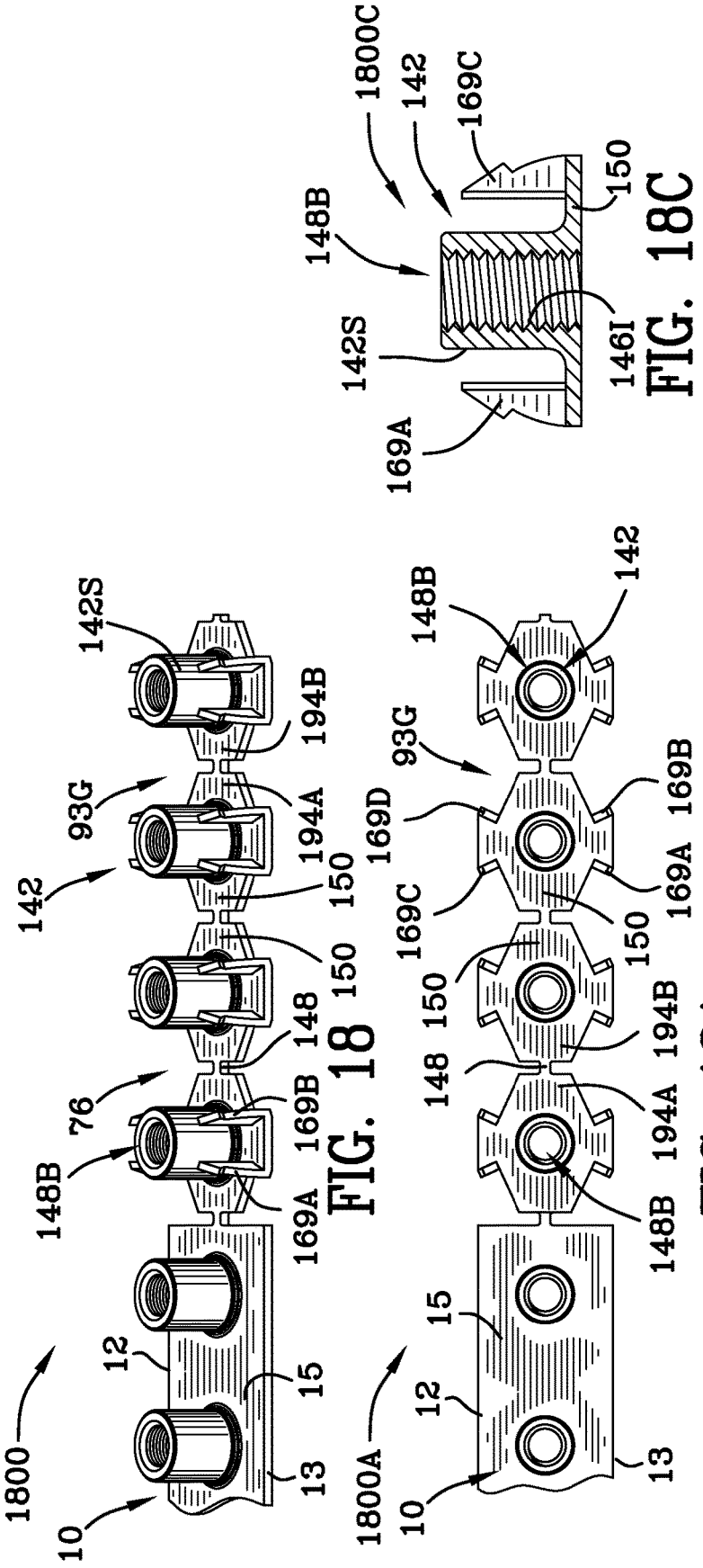


FIG. 18

FIG. 18A

FIG. 18C

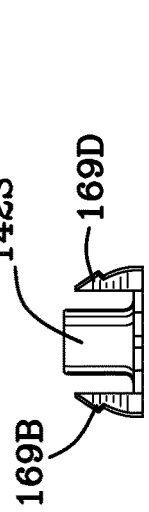


FIG. 18D

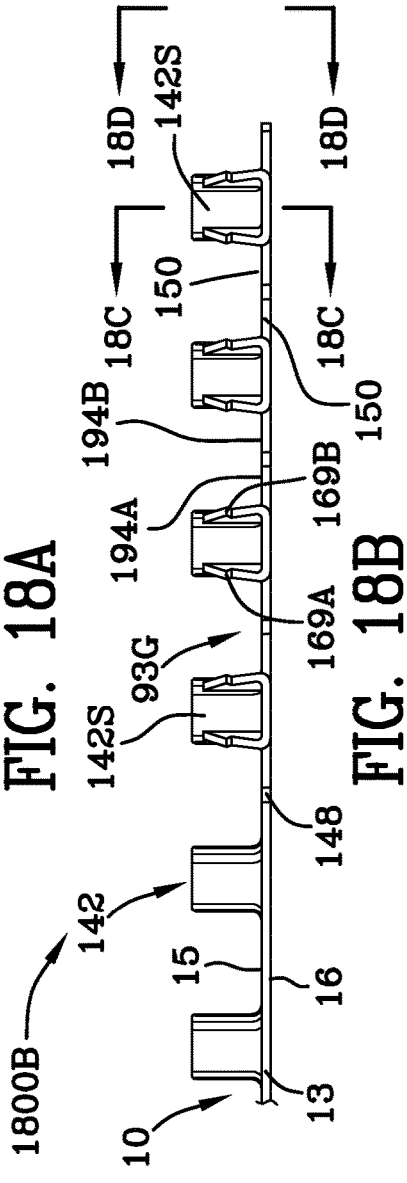


FIG. 18B

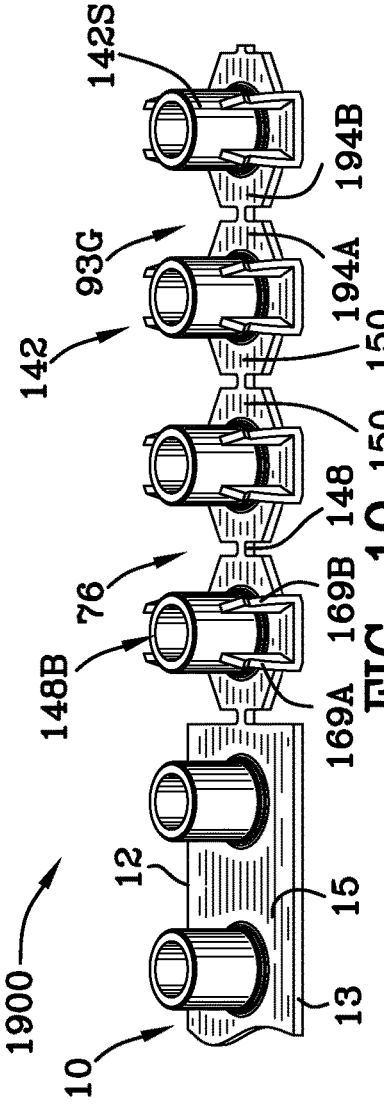


FIG. 19

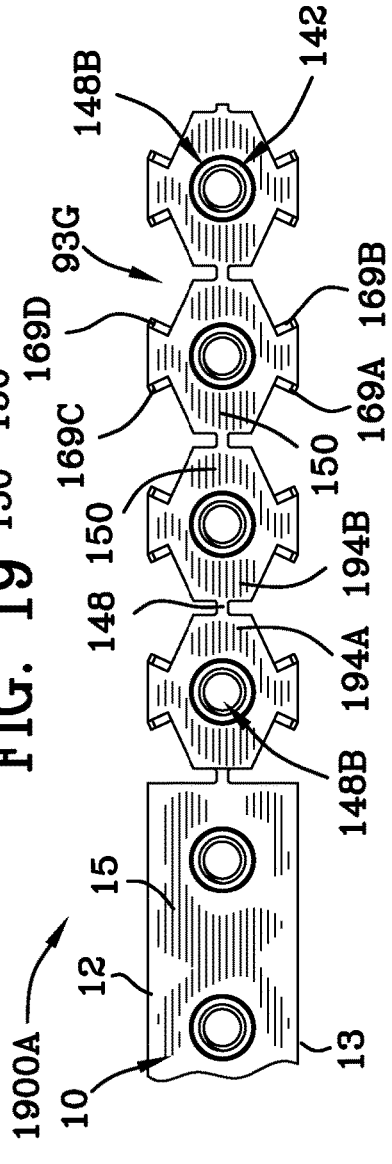


FIG. 19A

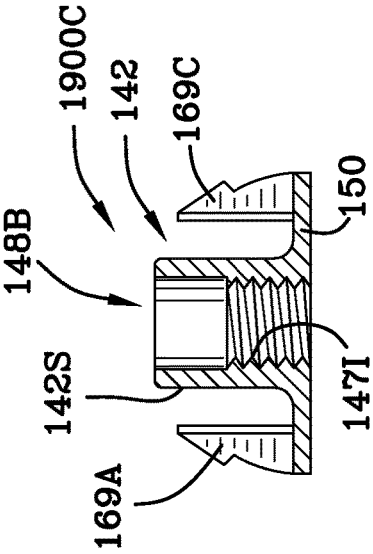


FIG. 19C

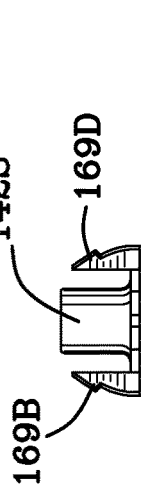


FIG. 19D

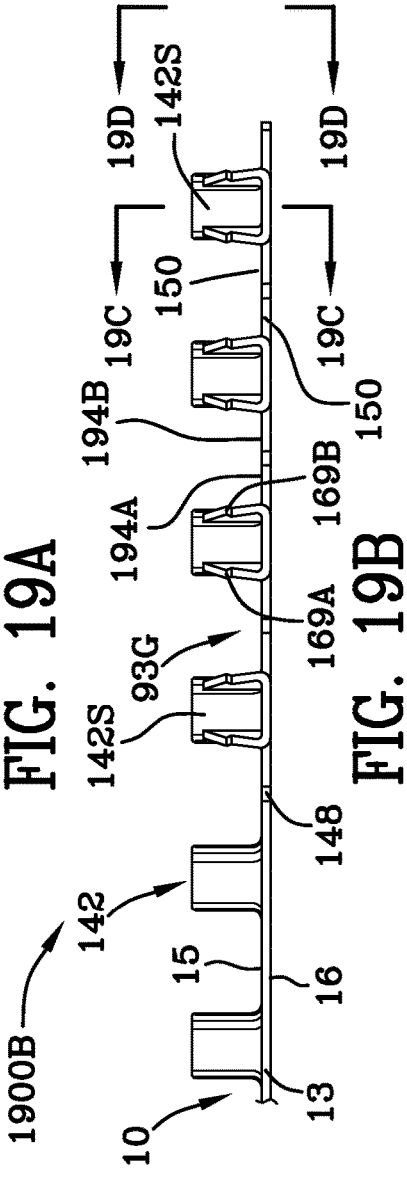


FIG. 19B

APPARATUS AND METHOD FOR SEVERING AND INSERTING COLLATED T-NUTS

This application claims priority to and the benefit of copending U.S. Provisional Patent Application Ser. No. 61/433,300 filed Jan. 17, 2011. U.S. Provisional Patent Application Ser. No. 61/433,300 filed Jan. 17, 2011 is incorporated in its entirety by reference hereto.

FIELD OF INVENTION

The invention is in the field of fasteners.

BACKGROUND OF THE INVENTION

Existing collated fasteners are manufactured and then collated using a secondary process. One process uses a progressive die method to cut the T-Nuts off from the steel or stainless steel strip and then tap the threads in a secondary process. The secondary process commonly uses glue to hold the fasteners together for later dispensation. Fasteners which are glued together include staples, nails, screws, clips, etc.

One known method for collating T-Nuts includes adhering the T-Nuts to tape and rolling them into a coil during a secondary operation. FIG. **13** is a view **1300** illustrating a prior art backing strip **1301** securing individual T-Nuts **1302** thereto by means of adhesive as illustrated in U.S. Pat. No. 5,214,843. FIG. **13**A is a view **1300**A illustrating a prior art device illustrated in U.S. Pat. No. 5,214,843 with wires **1304**, **1305** welded to individual T-Nuts **1302**.

Presently known methods of collating T-Nuts using tape have several disadvantages. First, T-Nuts can easily become detached or 'unstuck' from the tape. Factors such as temperature and humidity can have an adverse reaction on the adhesive properties of tape. Second, taped T-Nuts on a coil do not withstand impact well. Common forces involved with activities such as shipping and/or handling can cause T-Nuts to detach. Third, the tape is flexible and the coil of T-Nuts does not have very rigid structure. Tape coiled T-Nuts must be laid-out and kept flat. If they are moved into a vertical angle they can lose their coiled form and begin to unravel. All current methods of collating T-Nuts involve a secondary process to collate the fasteners.

In the most common manufacture of individual T-Nuts, a band or metal strip of steel is drawn wherein the barrels of the T-Nuts are formed. Once the barrels of the T-Nuts are formed, the T-Nuts are severed from the strip. Threads are then tapped in the barrels of the T-Nuts and prongs may be added if not previously formed in the drawing step.

In a less common manufacture of individual T-Nuts, a band or metal strip of steel is drawn wherein the barrels of a plurality of T-Nuts are formed and then multiple spindles tap the plurality of barrels of T-Nuts while they are still integral with the metal strip. Thereafter, prongs (pawls) of the are formed on the T-Nuts and the individual T-Nuts are severed from the band or metal strip.

SUMMARY OF THE INVENTION

The disclosed method of collating T-Nuts does not involve a secondary process. Because the disclosed method taps the T-Nuts while they are still on and integral with the metal strip a secondary process is not necessary. Collation of fasteners is used to ease the installation process of the fasteners. When fasteners are collated they are correctly assembled and consistently arranged in a fixed orientation.

Formed and collated T-Nuts arranged in a steel strip are used in conjunction with T-Nut delivery system.

The invention includes a plurality of collated T-Nuts that reside in a steel strip. The collated T-Nuts are installed by automation equipment that shears individual T-Nuts from the coil. T-Nuts are commonly installed into, but not limited to, the following materials: wood, particle board, medium-density fiberboard (MDF), plywood, and various plastics.

Any reasonable thickness, width, and length strip of low carbon steel or stainless steel may be used to form T-Nuts collated by carry tabs between the flanges of each T-nut. In other words, the T-Nuts are formed in and from a continuous metal strip. Carry tabs include a frangible portion which enables severing of the T-Nuts.

The T-Nuts may take many forms. They may have a straight barrel or the barrel may have a stepped exterior. The barrel may be tapered. The barrel may include a counterbore therein and the counterbore may be threaded or unthreaded. A bore through the T-Nut may be fully threaded completely therethrough. Alternatively, the bore through the T-Nut may be partially threaded therethrough. The barrel length can vary. Threads may be any size and fit of imperial or metric standards.

Barrels can have the option of having skives on them. Skives cause the T-Nut to twist upon insertion and help increase retention of the T-Nut in the component. This type of T-Nut is known as a Propell nut. The Propell T-Nut has various flange sizes and geometries. The flanges may have various features such as prongs, holes, and welding bosses of any size and configuration. Carry tabs are used to connect each T-Nut to another. Carry tabs are either frangible themselves or include a frangible portion. Size, shape and location of the carry tabs can vary. All T-nut configurations disclosed herein may have various flange sizes and geometries.

These steel or stainless steel coil T-Nuts are manufactured using a progressive die method. This process starts with a coil of steel or stainless steel being fed into a press containing several stages of dies. The dies draw the steel or stainless steel at several locations and form barrels.

After the barrels are formed the steel or stainless steel strip advances to a station where the barrels are tapped. After the barrels are tapped the strip is cut to form the flange shape and carry tab. Many different shapes and configurations of the flanges and carry tabs are disclosed herein.

The next stage of the process is to form flange features such as prongs, holes, or bosses. This stage is typically carried out in conjunction with cutting the T-Nut from the strip. Dies also create other features such as prongs (pawls) and apertures in the metal strip. In order to keep the T-Nuts collated on the coil, the prongs will be formed but the carry tab will remain intact. Instead of using the carry tab, other structure such as a railing or plural rails may be used to hold the T-Nuts together. After this the T-Nuts can be rolled up securely into a coil and the coil is sufficiently rigid so that the coil does not unravel.

Steel or stainless steel coil T-Nuts have advantages over individual detached T-Nuts. Complete manufacturing is executed in one single operation or series of operations. T-Nuts are formed, tapped, and rolled up on a coil without requiring any secondary operations. The time to produce T-Nuts decreases and production costs are reduced. Because T-Nuts are collated on a coil they can be wound up on a reel instead of being packaged in cardboard boxes, which reduces packaging costs. Some T-Nuts have geometries that typically present feeding issues in vibratory bowls and tracks. Collated T-Nuts of the invention simplify the feeding

process by eliminating the need for a vibratory bowl and track. T-Nut machines that feed T-Nuts using a vibratory bowl and track can experience feeding issues in a dusty/dirty environment.

T-Nut users in woodworking related industries experience problems with sawdust. Sawdust in the atmosphere can settle on the T-Nuts and cause jamming in vibratory bowls and tracks. Collated T-Nuts on a steel or stainless steel coil do not require vibratory bowls and tracks, therefore eliminating potential jamming. The collated parts disclosed herein that are fed into automation equipment do not require an electrical vibratory system to feed parts. Steel or stainless steel coil T-Nuts can be easily fed into automation equipment.

The need for lifting boxes of individual T-Nuts and pouring them into a vibratory machine hopper is eliminated by the invention. Multiple steel or stainless steel coils of the T-Nuts rolled up into a coil as disclosed herein can be stored directly on the machine frame and easily reloaded as needed. Also, since the T-Nut coils disclosed herein are stable, a larger coil can be loaded onto a pallet reel and fed into an installation machine to run even larger quantities of T-Nuts before having to reload.

Installation of steel or stainless steel coil T-Nuts is automated. To automate the installation of the steel or stainless steel coil T-Nuts, a feeding system is utilized to advance the T-Nuts. Some slack must be available to allow the T-Nuts to advance.

The T-Nuts on the coil, once completely formed, are advanced using a pneumatic cylinder(s) to push/pull the T-Nuts. The pneumatic cylinder is fitted with an engaging tool. In one example, the barrels of the T-Nuts may be engaged by the engaging tool.

When in position a shearing in-body will push the T-Nuts downward over the blade shearing an individual T-Nut from the strip. Once sheared from the strip, the detached T-Nut is free to be advanced further down and into the pilot hole of the component (substrate).

A method of making a continuous length of integrally connected T-Nuts is disclosed and claimed. The method includes the steps of: selecting a continuous length of deformable metal material which is generally flat in configuration and which has first and second side portions and top and bottom portions; introducing the deformable metal material progressively into successive die stations which act to successively form spaced and generally hollow cylindrical configurations on the upper surface of the metal material of successively greater diameter and axial length; moving the generally cylindrical configurations successively to another station whereat threads are formed on a hollow interior thereof; moving the threaded generally cylindrical configurations progressively to a still further station wherein heads are formed for the T-Nuts in the nature of flanges which define the perimeter of the heads and also form carry tabs, the carry tabs are frangible connections or include frangible connections between adjacent T-Nuts; and, arranging the integrally connected T-Nuts into a tight helical configuration for shipment or for manufacturing use.

Additionally, the method may include the steps of: feeding the continuous length of integrally connected T-Nuts into proximity of its use and severing the endmost T-Nut from the length of T-Nuts; and, attaching the severed endmost T-Nut to a substrate, the step of attaching the severed endmost T-Nut to a substrate includes inserting the cylindrical configuration thereof into a cylindrical opening in the substrate. Still additionally, the method includes the steps of: forming prongs, holes and/or bosses on the flanges.

The apparatus of a continuous length of integrally connected T-Nuts is disclosed and claimed as well. The apparatus of a continuous length of integrally connected T-Nuts, includes: a continuous length of deformable metal material which is generally flat in configuration; the continuous length of deformable metal material includes first and second side portions, a top portion and a bottom portion; a plurality of spaced and generally hollow cylindrical configurations extending vertically from the top portion of the metal member; the generally hollow cylindrical portions include interior threads therein; wall means on each of the T-Nuts defining a head therefor; the wall means further defines a carry tab intermediate adjacent T-Nuts, and, the carry tab comprises a weakened connection between the adjacent T-Nuts for ease in separating the T-Nuts. The apparatus may further include T-Nuts having prongs, holes and/or bosses formed on the head/flange.

Another example of a continuous length of integrally connected T-Nuts, includes: a continuous length of deformable metal material which is generally flat in configuration; the continuous length of deformable metal material includes first and second side portions, a top portion and a bottom portion; a plurality of spaced and generally hollow cylindrical configurations on each of the T-Nuts extending vertically from the top portion of the metal member, the generally hollow cylindrical portions include a bore therethrough with interior threads therein, and, the generally hollow cylindrical portions of the T-Nuts defining barrels therefor; wall means on each of the T-Nuts defining a head or flange therefor; and, the wall means further define a continuous rail interconnecting said T-Nuts.

An apparatus for severing a T-Nut from the end of a strip of T-Nuts is also disclosed and claimed, and includes: the strip of T-Nuts being formed on a common strip of metal; each of the T-Nuts of the strip of T-Nuts being integrally connected together at a frangible portion with a next adjacent T-Nut; each of the T-Nuts includes a cylindrical bore therein; a mechanism to feed and sever the strip of T-Nuts in endwise fashion, the mechanism includes a positioning member, and an endmost T-Nut being in engagement with the positioning member; the mechanism to feed and sever the strip of T-Nuts in endwise fashion further includes: a cutting blade positioned vertically below the position of the frangible portion when the endmost T-Nut is in engagement with the positioning member; and, the mechanism to feed and sever the strip of T-Nuts includes a shearing ram (shearing inbody) having a guide finger positioned axially in line with the cylindrical bore in the endmost T-Nut and adapted to move vertically from an upper to a lower position to engage the cutting blade with the frangible portion and sever the endmost T-Nut from the strip of T-Nuts. The apparatus for severing a T-Nut from the end of a strip of T-Nuts may further include a guide finger which resides in the cylindrical bore of the endmost T-Nut to carry the severed endmost T-Nut to another position separated from the strip of T-Nuts. Still additionally, the apparatus for severing may include components for inserting the T-Nut into a substrate wherein the substrate includes an opening therein.

The guide finger resides in the cylindrical bore of the endmost T-Nut to carry the severed endmost T-Nut to the opening in the substrate where the T-Nut is to reside to perform a support function in later use. A guide mechanism is located below the end of the strip of T-Nuts and includes a support wall surface to engage the penultimate T-Nut of the strip so as to maintain its integrity with the strip until the

penultimate T-Nut is severed from the strip means for moving the shearing ram vertically between upper and lower positions are also disclosed.

Another apparatus for severing a T-Nut from a strip of collated T-Nuts is disclosed. In this apparatus example, a double acting pneumatic cylinder drives a tool which is notched for engagement with the pawl of the T-Nuts. The tool is notched such that at least two gripping surfaces engage the pawl. Two pneumatic cylinders may be used to engage the strip of T-Nuts, the first cylinder operates from the first side of an escapement and the second cylinder operates from the second side of the escapement. The escapement is the device which feeds and severs the T-Nuts and enables the insertion into a substrate for use. The escapement includes a generally rectangularly shaped T-Nut passageway which enables T-Nuts to be pushed therethrough by one or more pawl engaging tools driven by pneumatic cylinders. The pneumatic cylinders index the collated strips of T-Nuts into a position where they can be subsequently severed under the force of a shearing inbody which is piston driven. The escapement includes a pivotal bottom arm which allows the strip of T-Nuts to be forced downwardly where a frangible or severable portion of the T-Nut assembly is brought into engagement with a shearing blade. The shearing inbody includes a guide (stud) which enters the bore of the T-Nut to be severed so as to ensure separation of the T-Nut from the collated strip of T-Nuts when the frangible portion (weakened portion) is brought into engagement with the shearing blade of the escapement. The strip of T-Nuts, during the feeding operation (the installation operation of the T-Nuts into a substrate), resides in the passageway of the escapement and as the T-Nuts are forced downwardly to be severed, the pivotal bottom arm rotates downwardly approximately the height of one T-Nut. The height of the T-Nut is measured from the top of the flange to the end of the barrel of the T-Nut. As the T-Nut to be severed is forced down such that its frangible portion (weakened portion) engages the shearing blade of the escapement, the strip of T-Nuts is rotated slightly downwardly. Therefore, there must be some slack in the strip of T-Nuts being fed into the escapement. The end of the coil closest to where the T-Nuts are to be installed must allow for flexibility in the vertical direction. The reason for this is to allow the T-Nuts to advance above the shearing blade.

The another apparatus for severing a T-Nut from the end of a strip of T-Nuts uses a common strip of metal. The common strip of metal includes a plurality of T-Nuts thereon. Each of the plurality of T-Nuts of the common strip of T-Nuts includes a flange integrally connected by a frangible portion with a flange of a next adjacent T-Nut. The plurality of T-Nuts of the common strip includes an endmost T-Nut. The endmost T-Nut is severed from the plurality of T-Nuts of the common strip. Each of the T-Nuts includes a bore therein and a pair of pawls. An escapement includes a T-Nut passageway. The T-Nut passageway includes a first side member, a second side member, an upper member and a pivotable bottom plate. The upper member is affixed to the first and second side members. The hinged bottom portion rotates between first and second positions. The escapement further includes a chamber for severing the endmost T-Nut. A gripping tool is affixed to a double acting piston. The escapement severs the endmost T-Nut of the plurality of T-Nuts of the common strip in endwise fashion. The escapement includes an opening and the gripping tool resides in the opening of the escapement positioned to alternately engage and disengage one pawl of the pair of pawls of one of the T-Nuts. The double acting piston (also sometimes referred to herein as a shearing inbody) forcefully moves in a first direction urging the gripping tool into engagement with the one pawl of the pair of pawls of one of the T-Nuts urging the endmost T-Nut into the chamber. The double piston and the gripping tool affixed thereto retracting, in a second direction, away from and out of engagement with the one pawl of the pair of pawls of one of the T-Nuts of the plurality of T-Nuts of the common strip of T-Nuts. The escapement further includes a cutting blade positioned vertically below the frangible portion of the endmost T-Nut when the endmost T-Nut is in the chamber. The shearing piston resides in the chamber and the shearing piston is movable between a first upper position and a second lower position. The shearing piston includes a guide for interengagement with the bore of the endmost T-Nut. An elastic band member operates between the fixed upper portion of the escapement and the hinged bottom portion of the escapement. As the piston moves from the first upper position to the second lower position, the guide of the shearing piston engages the bore of the endmost T-Nut. The piston engages the flange of the endmost T-Nut, and the plurality of T-Nuts of the common strip rotate the hinged bottom portion between first and second positions. The frangible portion of the endmost T-Nut is lowered to, and brought into engagement with, the cutting surface of the cutting blade severing the endmost T-Nut from the plurality of T-Nuts of the common strip.

The method of inserting a T-Nut from a common strip of metal including a plurality of T-Nuts into an opening in a substrate, wherein each of the T-Nuts being integrally connected together by a frangible portion (weakened portion) thereof intermediate adjacent T-Nuts and each of the T-Nuts includes a cylindrical portion, includes the steps of: feeding the strip of T-Nuts in endwise fashion to a severing position; cutting the endmost T-Nut at the frangible portion (weakened portion) to severe the endmost T-Nut from the common strip of metal; carrying the severed T-Nut to and inserting the cylindrical portion of the severed T-Nut into the opening in the substrate; and, supporting the end of the strip of the T-Nuts adjacent the severed endmost T-Nut being severed maintaining integrity of the T-Nuts adjacent the strip until they are in position to be severed.

It is an object of the invention to provide a coiled roll of T-Nuts which is stable and secure for feeding the T-Nuts into a machine which severs the T-Nuts and places them securely in a substrate.

It is an object of the invention to provide a strip of collated T-Nuts having a flexible connection between each T-Nut enabling the T-Nuts to be rolled up in a coil.

It is an object of the invention to provide a coiled roll of T-Nuts wherein each of the T-Nuts is secured to the next adjacent T-Nut by a frangible portion of the coiled roll of T-Nuts.

It is an object of the present invention to provide a coiled roll of T-Nuts wherein each of the T-Nuts is secured to the next adjacent T-Nut by carry tabs joined together by a frangible (weakened) portion which can later be severed in the installation or separation of the T-Nuts.

It is an object of the invention to include carry tabs between adjacent T-Nuts which are either frangible or include frangible portions thereof.

It is an object of the invention to provide a plurality of T-Nuts formed on and of a metal strip and to provide a frangible portion between adjacent spaced apart T-Nuts.

It is an object of the invention to provide T-Nuts formed on and of a metal strip and to provide various flanges, holes and prongs as features of the T-Nuts.

It is an object of the invention to form T-Nuts on and of a metal strip such that the T-Nuts may be reliably separated and installed in a wooden substrate.

It is an object of the invention to secure T-Nuts on and of a metal strip through use of one or more rails.

It is an object of the invention to provide an escapement and a chamber associated therewith which feed and severs the endmost T-Nut from a continuous strip of T-Nuts.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**, **1**A and **1**B schematically illustrate a die press at a first die station in three successive positions in operating on a strip of metal in performing the method of the present invention.

FIG. **1**C is a schematic isometric illustration of the end of the strip of metal as it leaves the press illustrated in FIG. **1**B.

FIG. **1**D schematically illustrates a die press at a second die station as operating on the strip of metal after it has left the position of FIG. **1**B in the condition of FIG. **1**C.

FIG. **1**E is a schematic isometric illustration of the end of the strip of metal as operated on in the press of FIG. **1**D.

FIG. **1**F schematically illustrates a die press at a third die station as operating on the strip of metal after it has left the position of FIG. **1**D in the condition of FIG. **1**E.

FIG. **1**G is a schematic isometric illustration of the end of the strip of metal as operated on in the press of FIG. **1**F.

FIG. **1**H schematically illustrates a die press at a fourth die station as operating on the strip of metal after it has left the position of FIG. **1**F in the condition of FIG. **1**G.

FIG. **1**I is a schematic isometric illustration of the end of the strip of metal as operated on in the press of FIG. **1**H.

FIGS. **2**, **2**A and **2**B schematically illustrate a fifth die station at which the cylindrical members produced at the previous stations are tapped and provided with threads.

FIG. **2**C is a schematic isometric illustration of the end of the strip of metal as operated on at the fifth die station of FIG. **2**B.

FIGS. **3**, **3**A and **3**B schematically illustrate a sixth station at which the strip of metal between the formed cylindrical members is die cut to produce the heads on the T-Nuts and produce various flange features such as attachment prongs as shown in FIG. **3**B.

FIG. **3**C is a schematic isometric illustration of the end of the strip of metal as operated on at the sixth die station of FIG. **3**B.

FIG. **4** is an isometric illustration similar to FIG. **3**B showing a slightly longer length of the connected and formed T-Nuts and slightly enlarged for detail.

FIG. **4**A is an enlarged portion of FIG. **4** illustrating the connection between adjacent T-Nuts and the location at which they will be severed at about their ultimate location of use.

FIG. **4**B is a plan view of FIG. **4**.

FIG. **4**C is an elevational view of FIG. **4**B.

FIG. **4**D is an end view of FIG. **4**C.

FIG. **4**E is an enlargement of the side portion of FIG. **4**C.

FIG. **5** is a schematic view illustrating the length of integrally connected T-Nuts as shown in FIGS. **4** through **4**D as wound into a helical configuration for ease in shipping and/or manufacturing.

FIG. **5**A is a schematic view of the T-Nuts shown in FIG. **5** in connection with one example of an apparatus to sever the endmost T-Nut from its strip and in position to be installed in a substrate.

FIG. **5**B is a schematic view of the apparatus of FIG. **5**A severing the endmost T-Nut from its strip and placing it in an aperture in a substrate.

FIG. **5**C is a schematic view of the apparatus of FIG. **5**B moved back in position to install another T-Nut from the end of the strip into another aperture in a substrate.

FIG. **5**D is a schematic side view of a strip of collated T-Nuts in combination with another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip.

FIG. **5**E is a schematic top view of a strip of collated T-Nuts in combination with the another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip.

FIG. **5**F is a schematic cross-sectional view of a strip of collated T-Nuts in combination with the another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip taken along the lines **5**F-**5**F of FIG. **5**D illustrating the piston (shearing inbody) and the tool for advancing the strip, and, illustrating the endmost T-Nut in the chamber for separation from the strip.

FIG. **5**G is a schematic cross-sectional view of a strip of collated T-Nuts in combination with the another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip taken along the lines of **5**G-**5**G of FIG. **5**E illustrating the endmost T-Nut in the chamber for separation from the strip and the shearing inbody (piston) and guide aligned with the endmost T-Nut.

FIG. **5**H is a schematic cross-sectional view of a strip of collated T-Nuts in combination with the another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip illustrating the hinged bottom plate of the escapement rotated downwardly enabling the frangible connection of the endmost T-Nut in the chamber for separation from the strip.

FIG. **5**I is a schematic cross-sectional view of a strip of collated T-Nuts in combination with the another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip illustrating the hinged bottom plate of the escapement returned to its home position supporting the strip of collated T-Nuts.

FIG. **5**J is a schematic cross-sectional view of a strip of collated T-Nuts in combination with the another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip illustrating the shearing inbody pushing and inserting the endmost T-Nut into a substrate.

FIG. **5**K is a schematic side view of a coiled roll of T-Nuts wound around core with the barrels oriented radially outwardly.

FIG. **5**L is similar to FIG. **5**E with the exception being that two pistons are illustrated for urging the T-Nuts into the chamber for insertion thereafter into a substrate.

FIGS. **6**, **6**A, **6**B and **6**C are views of another configuration of T-Nuts made in accordance with the present invention.

FIG. **6**D is an enlargement of the frangible portion of FIG. **6** which illustrates a slot in the upper portion of the frangible portion and vertical slots on both sides of the frangible portion.

FIGS. **7**, **7**A, **7**B and **7**C are views of a further configuration of T-Nuts made in accordance with the present invention.

FIG. **7**D is an enlargement of the frangible portion of FIG. **7** which illustrates a slot in the upper portion of the frangible portion and vertical slots on both sides of the frangible portion.

FIGS. **8**, **8**A, **8**B and **8**C are views of a still further configuration of T-Nuts made in accordance with the present invention.

FIG. **8**D is an enlargement of the frangible portion of FIG. **8** which illustrates a slot in the upper portion of the frangible portion and vertical slots on both sides of the frangible portion.

FIGS. **9**, **9**A, **9**B and **9**C are views of yet another configuration of T-Nuts made in accordance with the present invention.

FIG. **9**D is an enlargement of the frangible portion of FIG. **9** which illustrates a slot in the upper portion of the frangible portion and vertical slots on both sides of the frangible portion.

FIGS. **10**, **10**A, **10**B and **10**C are views of an additional configuration of T-Nuts made in accordance with the present invention.

FIG. **10**D is an enlargement of the frangible portion of FIG. **10** which illustrates a slot in the upper portion of the frangible portion and vertical slots on both sides of the frangible portion.

FIGS. **11**, **11**A, **11**B and **11**C are views of an additional configuration of T-Nuts made in accordance with the present invention.

FIG. **11**D is an enlargement of the frangible portion of FIG. **11** which illustrates a slot in the upper portion of the frangible portion and vertical slots on both sides of the frangible portion.

FIG. **12** is a block diagram of the processing of the metal strip.

FIG. **13** illustrates a prior art backing strip securing individual T-Nuts thereto by means of adhesive as illustrated in U.S. Pat. No. 5,214,843.

FIG. **13**A illustrates a prior art device illustrated in U.S. Pat. No. 5,214,843 with wires welded to individual T-Nuts.

FIG. **14** is an isometric illustration of a length of the strip of another example of collated T-Nuts slightly enlarged wherein the barrel has a first diameter having a first circumference and a second diameter having a second circumference.

FIG. **14**A is a slightly enlarged top schematic view of the collated T-Nuts of FIG. **14** illustrating the frangible connection between adjacent T-Nuts.

FIG. **14**B is a plan view of FIG. **14**.

FIG. **14**C is a cross-sectional view of FIG. **14**B taken along the lines **14**C-**14**C illustrating interior threads in the first diameter having a first circumference.

FIG. **14**D is an end view of FIG. **14**B taken along the lines **14**D-**14**D.

FIG. **14**E is a plan view similar to FIG. **14**B with a frangible connection having a slight underside indentation.

FIG. **14**F is an enlargement of a portion of FIG. **14**E illustrating the frangible connection having a slight indentation.

FIG. **15** is an isometric illustration of a length of the strip of another example of collated T-Nuts slightly enlarged wherein the barrel has a first diameter having a first circumference and a second diameter having a second circumference similar to FIG. **14**, except with interior threads completely through the barrel.

FIG. **15**A is a slightly enlarged top schematic view of the collated T-Nuts of FIG. **15** illustrating the frangible connection between adjacent T-Nuts.

FIG. **15**B is a plan view of FIG. **15**.

FIG. **15**C is a cross-sectional view of FIG. **15**B taken along the lines **15**C-**15**C illustrating a fully threaded barrel.

FIG. **15**D is an end view of FIG. **15**B taken along the lines **15**D-**15**D.

FIG. **16** is an isometric illustration of a length of the strip of another example of collated T-Nuts slightly enlarged wherein the barrel has a first diameter having a first circumference and a second diameter having a second circumference similar to FIG. **14**, except with interior threads residing in the portion of the barrel having a second diameter having a second circumference.

FIG. **16**A is a slightly enlarged top schematic view of the collated T-Nuts of FIG. **16** illustrating the frangible connection between adjacent T-Nuts.

FIG. **16**B is a plan view of FIG. **16**.

FIG. **16**C is a cross-sectional view of FIG. **16**B taken along the lines **16**C-**16**C illustrating interior threads in the second diameter having a second circumference.

FIG. **16**D is an end view of FIG. **16**B taken along the lines **16**D-**16**D.

FIG. **17** is an isometric illustration of a length of the strip of another example of collated T-Nuts slightly enlarged wherein the barrel is cylindrically shaped with interior threads in the upper portion of the bore of the cylindrically shaped barrel.

FIG. **17**A is a slightly enlarged top schematic view of the collated T-Nuts of FIG. **17** illustrating the frangible connection between adjacent T-Nuts.

FIG. **17**B is a plan view of FIG. **17**.

FIG. **17**C is a cross-sectional view of FIG. **17**B taken along the lines **17**C-**17**C illustrating interior threads in the upper portion of the bore.

FIG. **17**D is an end view of FIG. **17**B taken along the lines **17**D-**17**D.

FIG. **18** is an isometric illustration of a length of the strip of another example of collated T-Nuts slightly enlarged wherein the barrel is cylindrically shaped with interior threads completely through the bore of the cylindrically shaped barrel.

FIG. **18**A is a slightly enlarged top schematic view of the collated T-Nuts of FIG. **18** illustrating the frangible connection between adjacent T-Nuts.

FIG. **18**B is a plan view of FIG. **18**.

FIG. **18**C is a cross-sectional view of FIG. **18**B taken along the lines **18**C-**18**C illustrating interior threads through the entire bore of the cylindrically shaped barrel.

FIG. **18**D is an end view of FIG. **18**B taken along the lines **18**D-**18**D.

FIG. **19** is an isometric illustration of a length of the strip of another example of collated T-Nuts slightly enlarged wherein the barrel is cylindrically shaped with interior threads in the lower portion of the bore of the cylindrically shaped barrel.

FIG. **19**A is a slightly enlarged top schematic view of the collated T-Nuts of FIG. **19** illustrating the frangible connection between adjacent T-Nuts.

FIG. **19**B is a plan view of FIG. **19**.

FIG. **19**C is a cross-sectional view of FIG. **19**B taken along the lines **19**C-**19**C illustrating interior threads in the lower portion of the bore.

FIG. **19**D is an end view of FIG. **19**B taken along the lines **19**D-**19**D.

The invention will be best understood when reference is made to the description of the invention and to the claims which follow hereinbelow.

DESCRIPTION OF THE INVENTION

Reference may be had to FIG. **4** for a quick understanding of the continuous strip of collated T-Nuts of the invention.

The continuous strip comprises T-Nuts integrally connected together and spaced apart for later dispensation in a substrate. The integrally connected T-Nuts are formed on and from a continuous steel strip **10**. The strip shown in FIG. **4** has been identified by the reference numeral **33**. Put another way, reference numeral **33** identifies one example of the completed product, namely, a strip of collated T-Nuts with flanges and parts linked together by carry tabs and frangible portions. As stated previously, the carry tabs may be frangible or portions of the carry tabs may be frangible. The strip of deformable metal material **10** (FIG. **1**) has first and second side portions **12**, **13** and top and bottom portions **15**, **16** and is fed into a first die station **18** (FIGS. **1**, **1**A, **1**B) which is housed in press **34**. FIGS. **1**, **1**A and **1**B illustrate a die press at a first die station **18** in three successive positions **100**, **100**A, **100**B in operating on a strip of deformable metal material **10** in performing the method of the present invention. FIG. **1**C is an isometric illustration **100**C of the end of the strip of metal **10** as it leaves the press **34** illustrated in FIG. **1**B.

The strip of metal **10** may be made from many different steels of varying widths and thicknesses. Low carbon steels and 300 series stainless steels are examples. C**1006**-**1008** steel, 304 stainless steel, or any of their international equivalents may be used. The thicknesses of the steels varies, but most will be in the range of 0.039" [1.0 mm] to 0.063" [1.6 mm] thick. The width of the T-nuts also varies, but commonly the widths are in the range of 0.625" [15.9 mm] to 1.000" [25.4 mm] wide. Other widths and thicknesses are specifically contemplated.

The press includes upper and lower platens **35**, **36** which are normally urged apart by springs **37**, **38** and which press has upper and lower rams **39**, **40** which may be hydraulically actuated to bring the platens together to form the steel strip into the configurations described hereafter.

The die station **18** includes die members **18**A which act on the metal material **10** when the platens **35**, **36** are brought together as illustrated in FIG. **1**A and when they are separated as illustrated in FIG. **1**B. In FIG. **1**B the initial shapes of the cylindrical configurations of the T-Nuts has been formed and they have been identified by the reference numeral **22**. Die members **19**A at a second die station **19** serve to further enlarge the cylindrical members to the condition **22**A shown in FIG. **1**D. FIG. **1**D is a view **100**D illustrating a die press at a second die station **19** as operating on the strip of metal **10** after it has left the position of FIG. **1**B in the condition of FIG. **1**C. FIG. **1**E is an isometric illustration **100**E of the end of the strip of metal **10** as operated on in the press of FIG. **1**D.

Next the strip of deformable metal material is moved to a third die station **20** (FIG. **1**F) where die members **20**A act further on the cylindrical members to enlarge them further to the condition of **20**B seen in FIGS. **1**F and **1**G. FIG. **1**F is a view **100**F illustrating a die press at a third die station **20** as operating on the strip of metal **10** after it has left the position of FIG. **1**D in the condition of FIG. **1**E. FIG. **1**G is an isometric illustration **100**G of the end of the strip of metal **10** as operated on in the press of FIG. **1**F. FIG. **1**G illustrates that the cylindrical members are becoming longer and diametrically larger.

The metal strip is next moved to a fourth die station **21** where dies **21**A produce the final cylindrical shape **22**C shown in FIGS. **1**H and H. FIG. **1**H is a view **100**H illustrating a die press at a fourth die station **21** as operating on the strip of metal **10** after it has left the position of FIG. **1**F in the condition of FIG. **1**G. FIG. **1**I is an isometric illustration **1001** of the end of the strip of metal as operated on in the press of FIG. **1**H.

The strip of metal with the linearly spaced cylindrical members **22**C is next moved to a fifth station **24** where taps **28** are provided and are moved axially into members **22**C to provide internal threads **44** thereon and produce the internally threaded members now identified at **42**. FIGS. **2**, **2**A and **2**B illustrate **200**, **200**A, **200**B, a fifth die station **24** at which the cylindrical members **42** produced at the previous stations are tapped and provided with threads. FIGS. **2**, **2**A and **2**B illustrate successive steps **200**, **200**A, **200**B in tapping the internal threads within the cylindrical members **42**. FIG. **2**C is an isometric illustration **200**C of the end of the strip of metal as operated on at the fifth die station of FIG. **2**B.

The next step in the process of producing the collated T-Nut construction of the invention is to die cut the flanged head construction of the nut and to produce any desired flange or attachment feature. To this end, the metal strip **10** is moved to a sixth station **25** where a die **25**A, not shown in any specific configuration, but which has a pattern corresponding to the shape produced thereby, produces strip **33** of the finished and integrally connected T-Nuts **33** referred to above in this description. The die **25**A takes the necessary configuration to produce T-Nuts as illustrated in FIGS. **4**, **6**, **7**, **8**, **9**, **10**, **11**, **14**, **15**, **16**, **17**, **18**, and **19**. Other configurations not shown in FIGS. **4**, **6**, **7**, **8**, **9**, **10**, **11**, **14**, **15**, **16**, **17**, **18**, and **19** are specifically contemplated. FIGS. **3**, **3**A and **3**B are view **300**, **300**A, **300**B, respectively, illustrating a sixth station **25** at which the strip of metal **10** between the formed cylindrical members is die cut to produce the flanged heads on the T-Nuts and produce various flange features such as attachment prongs as shown in FIGS. **3**B and **3**C. FIG. **3**C is an isometric illustration **300**C of the end of the strip of metal **10** as operated on at the sixth die station of FIG. **3**B.

The finished and completed strip **33** includes the collated T-Nuts which comprise the spaced cylindrically shaped members **42** which are internally threaded at **44** and which have flanged heads **50** with attachment prongs **46** formed at a position which can be said to be at the first and second side portions **12**, **13** of the metal strip **10**. A frangible portion **48** is formed in the die cutting operation of FIGS. **3**, **3**A and **3**B and serves to define the interconnection between adjacent T-Nuts. A carry tab from each adjacent T-Nut of the strip is connected to the frangible portion. The frangible portion is of such thickness and strength to keep the plurality of T-Nuts connected in shipment and when otherwise being moved and handled. The frangible portion is also of a thickness and strength that it can conveniently be severed from the strip enabling installation in its ultimate place of use, for instance, in an opening in a substrate.

FIG. **4** is an isometric illustration **400** similar to FIG. **3**B showing a slightly longer length of the connected and formed T-Nuts and which is slightly enlarged for detail. FIG. **4**A is an enlarged portion **400**A of FIG. **4** illustrating the carry tabs and frangible portion **48** thereof between adjacent T-Nuts. Frangible portion **48** is the location at which the adjacent T-Nuts will be severed. Carry tabs **92**A, **92**B are illustrated on either side of frangible portion **48**. FIG. **4**B is a plan view **400**B of FIG. **4**. FIG. **4**C is an elevational view **400**C of FIG. **4**B. FIG. **4**D is an end view **400**D of FIG. **4**C. Arrow **93** in FIG. **4** indicates the interconnection between adjacent T-Nuts. A frangible portion **48** in combination with tabs **92**A, **92**B join adjacent T-Nuts together. Sometimes the tabs **92**A, **92**B are referred to herein as carry tabs. Carry tabs

92A, 92B and the frangible portion 48 thereof are used to join the T-Nuts together and enable further processing of the T-Nuts and installation of the T-Nuts into a substrate. FIG. 4A is an enlargement 400A of the frangible portion 48 which illustrates slot 90 in the upper portion of the frangible portion and vertical slots 91, 91 on both sides of the frangible portion. FIG. 4E is an enlargement 400E of the side portion of FIG. 4C illustrating vertical slot 91 in the frangible portion 48.

FIG. 5 is a view 500 illustrating a length of integrally connected T-Nuts as shown in FIGS. 4 through 4E as wound into a helical configuration for ease in shipping and/or handling for further processing. FIG. 5A is a view 500A of the T-Nuts shown in FIG. 5 in connection with one example of an apparatus to sever the endmost T-Nut from completed strip 33 and position the endmost T-Nut for installation in a substrate. FIG. 5B is a view 500B of the apparatus of FIG. 5A severing the endmost T-Nut from its strip 33 and placing it in an aperture in a substrate. FIG. 5C is a view 500C of the apparatus of FIG. 5B moved back in position to install another T-Nut from the end of the strip into another aperture in a substrate.

Referring again to FIG. 5, the strip 33 of T-Nuts is wound in a helical pattern for shipment or to be placed on a mandrel in a manufacturing operation of placing the individual T-Nuts into a substrate to receive and hold a support screw in a fastener application. The frangible portion 48 enables the coil to be wound more readily because the frangible portion is a weakened portion. Because the frangible portion 48 is narrow in cross-section it is easily bent enabling a long strip 33 of T-Nuts to be wound in a coil. The frangible portion 48 need not include a slot or slit therein. See FIGS. 14, 15, 16, 17, 18 and 19. Coils having approximately 1100 T-Nuts can be wound and are stable.

FIGS. 5A, 5B and 5C are views 500A, 500B, 500C, respectively, illustrating the apparatus and method of use of the completed strip 33 of helically wound T-Nuts shown in FIG. 5. The apparatus includes a shearing station 52 and has a positioning abutment 53 adapted to engage and position the end of the strip 33 which is driven into the position of FIG. 5A by an advancement finger 54 which pivots on a torsion spring driven by a pneumatic cylinder, not shown. A shearing blade assembly 55 is located below the end of the strip 33 and includes a blade 56, and guide cylinders 57, each of which are biased upwardly by springs 58.

A shearing ram 59 is positioned above the end of strip 33 and has a guide finger 60 which is adapted to fit into the opening in the endmost T-Nut. The two T-Nuts next adjacent the endmost T-Nut are adapted to fit into and be supported by the guide cylinders 57 during a shearing operation by the downward movement of ram 59 causing the tab 48 of the endmost T-Nut to engage blade 56 and to be severed from the strip. The finger 60 carries the severed T-Nut to an opening 61 in a substrate 89 where it is to reside. The ram 59 is then returned to the position of FIG. 5C preparatory to another cycle. Reference numeral 81 signifies the horizontal movement of the continuous strip of T-Nuts, reference numeral 82 indicates the vertical movement of the continuous strip of T-Nuts, and reference numeral 83 indicates the horizontal movement of the substrate 89.

Another apparatus for severing a T-Nut from the end of a strip of T-Nuts is disclosed in FIGS. 5D to 5J, and 5L. FIG. 5D is a schematic side view 500D of a strip 74 of collated T-Nuts in combination with another example of an apparatus 599 (an escapement) to sever the endmost T-Nut 74E from its strip 74. See FIG. 5K which is a schematic side view 500K of a coiled roll 598 of T-Nuts wound around core 597 with the barrels 142 oriented radially outwardly. The continuous strip 74 of T-Nuts is easily wound as the frangible portions 148 between carry tabs and flanges 150, 150 of adjacent T-Nuts is bendable without severing the adjacent T-Nuts from each other. Each T-Nut includes a barrel 142, a plurality of prongs 169A, 169B, 169C and 169D, a flange 150, carry tabs 194A, 194B, and a frangible portion 148 connected to adjacent T-Nuts.

A common strip 74 of metal includes a plurality of T-Nuts thereon as illustrated in FIG. 5K. The strip 74 is fed into an escapement 599. Referring to FIGS. 5D, 5E, 5F, 5G, 5H and 5I, strip 74 includes a plurality of T-Nuts in escapement 599. Escapement 599 includes a chamber 599A where the endmost T-Nut 74E is severed.

Referring to FIG. 5D, shearing ram inbody 501 shears the endmost T-nut 74E from the strip 74 of integrally connected T-Nuts. Guide 501G of inbody 501 is illustrated in section in FIGS. 5E and 5G. Guide 501G engages the bore of the endmost T-Nut 74E in the severing process.

FIG. 5E is a schematic top view 500E of the strip 74 of collated T-Nuts in combination with the another example of an apparatus 599 (an escapement) to sever the endmost T-Nut 74E from its strip.

FIG. 5G is a schematic cross-sectional view 500G of the strip 74 of collated T-Nuts in combination with the another example of an apparatus 599 (an escapement) to sever the endmost T-Nut 74E from its strip 74 taken along the lines of 5G-5G of FIG. 5E illustrating the endmost T-Nut 74E in the chamber 599A for separation from the strip 74 and the shearing inbody 501 and guide 501G aligned with the endmost T-Nut 74E.

FIG. 5F is a schematic cross-sectional view 500F of the strip 74 of collated T-Nuts in combination with the another example of an apparatus 599 (an escapement) to sever the endmost T-Nut 74E from its strip taken along the lines 5F-5F of FIG. 5D illustrating the piston 530 and the gripping tool 530T for advancing the strip 74, and, illustrating the endmost T-Nut 74E in the chamber 599A for separation from the strip 74. FIG. 5L is similar to FIG. 5E with the addition of a second piston 530A which resides in slot 532. See FIG. 5D for an illustration of open slot 531 in side wall 503 and open slot 532 in side wall 503A. Open slot in side wall 503 permits access of gripping tool 530T to pawls/prongs of T-Nuts on strip 74. Open slot in side wall 503A permits access of gripping tool 530T to pawls/prongs of T-Nuts on strip 74. Guiding surfaces 531S, 532S direct gripping tools 530T, 530T along side walls 503, 503A and into engagement with the prongs/pawls of the T-Nuts. Referring to FIG. 5F, surfaces 540R, 541R of tool 530T engage corresponding surfaces 540, 541 of the prong/pawl.

Gripping tool 530T resides in openings 531, 532 of the escapement and is positioned to alternately engage and disengage one pawl of the pair of pawls of one of the T-Nuts. Double acting piston 530 forcefully moves in a first direction urging the gripping tool 530T into engagement with one pawl of the pair of pawls of one of the T-Nuts urging the endmost T-Nut 74E into the chamber. See FIG. 5F. Double acting piston and the gripping tool affixed thereto retracts, in a second direction, away from and out of engagement with the one pawl of the pair of pawls of one of the T-Nuts of the plurality of T-Nuts of the common strip of T-Nuts.

Referring to FIGS. 5D and 5E, rod 530R of tool 530T is illustrated. When piston 530 is extended in the first direction toward the strip 74 of T-Nuts for engagement therewith, rod 530R is in sliding engagement with side wall 503 and pivots the arm clockwise when viewing FIGS. 5E and 5F against the force, F, applied by a spring. The spring operates

between the piston **530** and a point affixed to the frame of which the escapement is a part thereof. Piston **530** pivots about shaft **530**P and nut **530**N is affixed to the shaft and rotates therewith. Pressure ports **530**P, **530**Q are illustrated in FIG. **5**E and supply pressure to the double acting piston **530**. Double acting piston **530** extends the gripping tool **530**T in a first direction toward the strip **74** of T-Nuts and into engagement therewith. Double acting piston **530** also retracts the gripping tool **530**T away from the strip **74** of T-Nuts. Force, F, of the spring or other biasing member such as an elastic band, ensures the proper orientation of the gripping tool **530**T. Gripping tool **530**T is affixed to a shaft of the piston and is moveable therewith.

Referring to FIGS. **5**D and **5**E, upper portion **502** and side wall **503** of the escapement is illustrated. FIG. **5**F illustrates side wall **503**A. Side walls **503**, **503**A are affixed to upper portion **502** of escapement **599**. Bolts **502**N illustrated in FIG. **5**E affix the upper portion **502** of the escapement **599** to side walls **503**, **503**A. Hinged bottom of escapement **550** is illustrated in FIGS. **5**F and **5**G and fits substantially within walls **503**, **503**A. Hinged bottom **550** rotates about pivot **504**P shown in FIG. **5**G. Nuts **504**, **504**A shown in FIGS. **5**D and **5**F secure the pivot **504**P to side walls **503**, **503**A. Referring to FIG. **5**D, lower portion **507** of the hinged bottom **550** is illustrated. Lower pin **506** is affixed to the hinged bottom **550**. Upper pin **505** is affixed to upper portion **502** of the escapement. Elastic band **531** operates between upper pin **505** and lower pin **506** and serves to restrain the rotation of the hinged bottom unless the strip **74** of T-Nuts is under the force of shearing inbody **501** as illustrated in FIG. **5**H.

FIG. **5**H is a schematic cross-sectional view **500**H of a strip **74** of collated T-Nuts in combination with the another example of an apparatus **599** (an escapement) to sever the endmost T-Nut **74**E from its strip illustrating the hinged bottom plate **550** of the escapement **599** rotated downwardly enabling the frangible connection **148** of the endmost T-Nut **74**E in the chamber **599**A to be separated from the strip **74**. Chamber **599**A includes plates **510**, **511**, **511**A, **512** which form a square in cross-section. Other geometric chamber forms could be used, for example, rectangular, circular, etc. and other geometric shearing inbody forms could be used. The square shape has been found to sever the frangible connections **148** well.

FIG. **5**I is a schematic cross-sectional view **500**I of a strip **74** of collated T-Nuts in combination with the another example of an apparatus **599** (an escapement) to sever the endmost T-Nut **74**E from its strip illustrating the hinged bottom plate **550** of the escapement **599** returned to its home position (first position) supporting the strip **74** of collated T-Nuts. FIG. **5**J is a schematic cross-sectional view **500**J of a strip **74** of collated T-Nuts in combination with another example of an apparatus **599** (an escapement) to sever the endmost T-Nut **74**E from its strip **74** illustrating the shearing inbody **501** pushing and inserting the endmost T-Nut **74**E into an opening **558** substrate **560**. After the endmost T-Nut **74**E has been fully inserted in the opening **558**, the shearing inbody **501** is retracted to its home position (upper position) as illustrated in FIG. **5**G above the strip **74** of T-Nuts. Shearing inbody **501**, when moved from its lower position to its upper position, is then ready for another cycle of shearing and inserting the endmost T-Nut. The shearing inbody **501** is driven by a piston (not shown) and the action of the shearing inbody and the piston **530** is coordinated to properly deliver the endmost T-Nut to the chamber **599**A at the appropriate time.

Referring to FIGS. **5**D, **5**F, **5**G, **5**H, **5**I and **5**J, cutting blade **508** is illustrated. In FIG. **5**F, endmost T-Nut **74**E is illustrated in chamber **599**A. Frangible portion **148** connecting the endmost T-Nut with the next adjacent T-Nut is positioned in alignment with cutting surface **508**C of cutting blade **508**. In FIG. **5**G, frangible portion **148** is aligned with cutting surface **508**C of the cutting blade **508**. Cutting blade **508** is affixed to plate **510** by bolt **509**. In FIG. **5**H, shearing inbody **501** is illustrated in engagement with the endmost T-Nut **74**E pushing it downwardly and, simultaneously, shearing inbody pushes the adjacent T-Nut and the next several T-nuts downwardly against the bottom plate **550** of the escapement. Frangible portions **148** of the T-Nuts do not break apart or sever as viewed in FIG. **5**H. Rather, the frangible portions are sufficiently strong so as to not separate when the shearing inbody (piston) **501** engages the endmost T-Nut **74**E and pushes it down to the cutting surface **508**C of the cutting blade **508**. The force applied to the bottom plate **550** is resisted by the elastic band **513** illustrated in FIG. **5**D. As bottom plate **550** rotates clockwise about pivot **504**P, the elastic band stretches due to the force being applied to the strip **74** of T-Nuts by the shearing inbody **501**. Once the frangible interconnection is broken or severed, then the strip **74** of T-Nuts and the bottom plate **550** are repositioned under the force of the elastic band **513** to an initial or home position as illustrated in FIG. **5**I. Referring to FIGS. **5**F and **5**G, passageway **520**P for strip **74** is illustrated and is formed by the upper portion **502**, sidewalls **503**, **503**A and the pivotal bottom plate or portion **550**.

FIGS. **6** through **11**, and **14** through **19**, illustrate various configurations of the collated strip **62**, **64**, **88**, **68**, **70**, and **72** of integrally connected T-Nuts. All of these examples are made in accord with the teachings of the present invention. FIGS. **6**, **6**A, **6**B and **6**C are views **600**, **600**A, **600**B and **600**C, respectively, of another configuration of T-Nuts made in accordance with the present invention. FIG. **6** illustrates a strip of collated T-Nuts **62** with an oblong-shaped flanged head with a frangible connection portion **48**A. The oblong-shaped flanged head is provided with holes **63** which provide a secondary support means for affixation to a substrate **89**. Arrow **93**A in FIG. **6** indicates the interconnection between adjacent T-Nuts. A frangible portion **48**A in combination with carry tabs **94**A, **94**B join adjacent T-Nuts together enabling further processing. Carry tabs **94**A, **94**B and frangible portion **48**A are used to join the T-Nuts together and enable further processing of the T-Nuts and installation of the T-Nuts into a substrate. FIG. **6**D is an enlargement **600**D of the frangible portion **48**A which illustrates slot **90**A in the upper portion of the frangible portion and vertical slots **91**A, **91**A on both sides of the frangible portion.

FIGS. **7**, **7**A, **7**B and **7**C are views **700**, **700**A, **700**B and **700**C, respectively, of a further configuration or example of T-Nuts made in accordance with the present invention with a frangible connection portion **48**B. FIG. **7** illustrates a further variation in the head shape that can be applied to the strip **64** of collated T-Nuts and illustrates the provision of skives **65** on the exterior of the cylindrical shapes which enable the T-Nut to be more firmly attached to the substrate to which it is applied. Arrow **93**B in FIG. **7** indicates the interconnection between adjacent T-Nuts. A frangible portion **48**B in combination with carry tabs **95**A, **95**B join adjacent T-Nuts together enabling further processing. Carry tabs **95**A, **95**B and frangible portion **48**B are used to join the T-Nuts together and enable further processing of the T-Nuts and installation of the T-Nuts into a substrate. FIG. **7**D is an enlargement **700**D of the frangible portion **48**B which illus-

trates slot **90**B in the upper portion of the frangible portion **48**B and vertical slots **91**B, **91**B on both sides of the frangible portion.

FIGS. **8**, **8**A, **8**B and **8**C are views **800**, **800**A, **800**B, **800**C, respectively, of a still further configuration or example of T-Nuts made in accordance with the present invention with a frangible connection portion **48**C. FIG. **8** shows a strip **66** of T-Nuts with a variation in the flange design and with attachment prongs **67** of different design than previously illustrated. Arrow **93**C in FIG. **8** indicates the interconnection between adjacent T-Nuts. A frangible portion **48**C in combination with carry tabs **96**A, **96**B join adjacent T-Nuts together enabling further processing. Carry tabs **96**A, **96**B and frangible portion **48**C are used to join adjacent T-Nuts together and enable further processing of the T-Nuts and installation of the T-Nuts into a substrate. FIG. **8**D is an enlargement **800**D of the frangible portion **48**C which illustrates the slot **90**C in the upper portion of the frangible portion and vertical slots **91**C, **91**C on both sides of the frangible portion.

FIGS. **9**, **9**A, **9**B and **9**C are views **900**, **900**A, **900**B, **900**C, respectively, of yet another configuration or example of T-Nuts made in accordance with the present invention with a frangible connection portion **48**D. FIG. **9** shows a strip of T-Nuts **68** with a still further flange head shape and a slightly different attachment prong **69** design. Arrow **93**D in FIG. **9** indicates the interconnection between adjacent T-Nuts. A frangible portion **48**D in combination with carry tabs **97**A, **97**B join adjacent T-Nuts together enabling further processing. Carry tabs **97**A, **97**B and frangible portion **48**D are used to join adjacent T-Nuts together and enable further processing of the T-Nuts and installation of the T-Nuts into a substrate. FIG. **9**D is an enlargement **900**D of the frangible portion **48**D which illustrates the slot **90**D in the upper portion of the frangible portion and vertical slots **91**D, **91**D on both sides of the frangible portion.

FIGS. **10**, **10**A, **10**B and **10**C are views **1000**, **1000**A, **1000**B, **1000**C, respectively, of an additional configuration or example of T-Nuts made in accordance with the present invention with a frangible connection portion **48**E. FIG. **10** illustrates another flange shape for a strip **70** of T-Nuts which have attachment prongs **71** similar to the ones previously shown. FIG. **10** also illustrates the variation in the frangible portion **48**E which is used to connect adjacent T-Nuts together. Arrow **93**E in FIG. **10** indicates the interconnection between adjacent T-Nuts. A frangible portion **48**E in combination with carry tabs **98**A, **98**B join adjacent T-Nuts together enabling further processing. Carry tabs **98**A, **98**B and frangible portion **48**E are used to join adjacent T-Nuts together and enable further processing of the T-Nuts and installation of the T-Nuts into a substrate. FIG. **10**D is an enlargement **1000**D of the frangible portion **48**E. FIG. **10**D illustrates the slot **90**E in the upper portion of the frangible portion **48**E and the vertical slots **91**E, **91**E on both sides of the frangible portion **48**E.

FIGS. **11**, **11**A, **11**B and **11**C are views **1100**, **1100**A, **1100**B, **1100**C, respectively, of the final example of T-Nuts made in accordance with the present invention. FIG. **11** is a still further variation of a strip of T-Nuts **72** which are connected together by metal rails **73** by leaving a portion of the first and second portions of the metal strip intact or in place so that these thin or narrow portions are all that need be severed in putting the T-Nuts in place. Arrow **93**F in FIG. **11** indicates the interconnection between adjacent T-Nuts. A frangible portion **48**F in combination with carry tab **99**A, **99**B join adjacent T-Nuts together enabling further processing. Carry tabs **99**A, **99**B and frangible portion **48**F are used to join adjacent T-Nuts together and enable further processing of the T-Nuts and installation of the T-Nuts into a substrate. FIG. **11**D is an enlargement **1100**D of the frangible portions **48**F, **48**F. FIG. **11** illustrates the slots **90**F, **90**F in the upper portion of the frangible portion **48**E and the vertical slots **91**F, **91**F on both sides of the frangible portion.

FIGS. **14**, **14**A, **14**B, **14**C, **14**D, **14**E and **14**F are views **1400**, **1400**A, **1400**B, **1400**C, **1400**D, **1400**E, and **1400**F, respectively, of a still further configuration or example of T-Nuts of the present invention with a frangible portion **148**. The frangible portion **148** is a weakened connection which can be easily severed as illustrated in FIGS. **5**D-**5**J. FIG. **14** shows a strip **74** of T-Nuts with a variation in the flange design **150** and with attachment prongs **169**A, **169**B, **169**C, **169**D of different design than previously illustrated. Arrow **93**G in FIG. **14** indicates the interconnection between adjacent T-Nuts. Carry tabs **194**A, **194**B include a frangible portion **148**. The frangible portion **148** in combination with carry tabs **194**A, **194**B join adjacent T-Nuts together enabling further processing. Carry tabs **194**A, **194**B and frangible portion **148** thereof are used to join adjacent T-Nuts together and enable further processing of the T-Nuts and installation of the T-Nuts into a substrate. Carry tabs **194**A, **194**B include the portion of the flange **150** proximate the frangible portion **148**.

FIG. **14** is an isometric illustration **1400** of a length of the strip **74** of another example of collated T-Nuts slightly enlarged wherein the barrel **142** has a first diameter having a first circumference **142**T and a second diameter having a second circumference **142**B. FIG. **14**A is a slightly enlarged top schematic view **1400**A of the collated T-Nuts of FIG. **14** illustrating the frangible connection **148** between adjacent T-Nuts. FIG. **14**B is a plan view **1400**B of FIG. **14**. Bores **152**B through T-Nuts are illustrated well in FIGS. **14**-**14**C. FIG. **14**C is a cross-sectional view **1400**C of FIG. **14**B taken along the lines **14**C-**14**C illustrating interior threads **1421** in the first diameter having a first circumference **142**T. FIG. **14**D is an end view **1400**D of FIG. **14**B taken along the lines **14**D-**14**D.

FIG. **14**E is a plan view **1400**E similar to FIG. **14**B with a frangible connection **148**Z having a slight underside **48**Z indentation. FIG. **14**F is an enlargement **1400**E of a portion of FIG. **14**E illustrating frangible connection **148**Z having a slight indentation **48**Z. The indentation **48**Z is sometimes a consequence of manufacturing the characteristics of the flange

FIGS. **15**, **15**A, **15**B, **15**C, and **15**D are views **1500**, **1500**A, **1500**B, **1500**C, and **1500**D respectively, of a configuration or example of T-Nuts similar to those illustrated in FIG. **14**. FIG. **15** is an isometric illustration **1500** of a length of the strip **74** of another example of collated T-Nuts slightly enlarged wherein the barrel **142** has a first diameter having a first circumference **142**T and a second diameter having a second circumference **142**B similar to FIG. **14**, except with interior threads **1431** completely through the barrel **142**. FIG. **15**A is a slightly enlarged top schematic view **1500**A of the collated T-Nuts of FIG. **15** illustrating the frangible connection **148** between adjacent T-Nuts. The frangible connection is a weakened portion which may be severed as illustrated in FIGS. **5**D-**5**J. FIG. **15**B is a plan view **1500**B of FIG. **15**. FIG. **15**C is a cross-sectional view **1500**C of FIG. **15**B taken along the lines **15**C-**15**C illustrating a fully threaded **143**I barrel **142**. Bore **152**B is illustrated well in FIGS. **15**, **15**A and **15**C. FIG. **15**D is an end view **1500**D of FIG. **15**B taken along the lines **15**D-**15**D.

FIGS. **16**, **16**A, **16**B, **16**C, and **16**D are views **1600**, **1600**A, **1600**B, **1600**C, and **1600**D respectively, of a con-

figuration or example of T-Nuts similar to those illustrated in FIG. **14**. FIG. **16** is an isometric illustration **1600** of a length of the strip **74** of another example of collated T-Nuts slightly enlarged wherein the barrel **142** has a first diameter having a first circumference **142**T and a second diameter having a second circumference **142**B similar to FIG. **14**, except with interior threads **144**I residing in the portion of the barrel **142** having a second diameter having a second circumference **142**B. FIG. **16**A is a slightly enlarged top schematic view **1600**A of the collated T-Nuts of FIG. **16** illustrating the frangible connection **148** between adjacent T-Nuts. The frangible connection or portion **148** is a weakened portion which may be easily severed as illustrated in FIGS. **5**D-**5**J. FIG. **16**B is a plan view **1600**B of FIG. **16**. FIG. **16**C is a cross-sectional view **1600**C of FIG. **16**B taken along the lines **16**C-**16**C illustrating interior threads **144**I in the second diameter having a second circumference **142**B. FIG. **16**D is an end view **1600**D of FIG. **16**B taken along the lines **16**D-**16**D.

FIGS. **17**, **17**A, **17**, **17**C, and **17**D are views **1700**, **1700**A, **1700**B, **1700**C, and **1700**D, respectively, of a still further configuration or example of T-Nuts made in accordance with the present invention with a frangible portion **148**. FIG. **17** shows a strip **76** of T-Nuts with a flange design **150** and with attachment prongs **169**A, **169**B, **169**C, **169**D of identical to those illustrated in FIG. **14**. Arrow **93**G in FIG. **17** indicates the interconnection between adjacent T-Nuts. Carry tabs **194**A, **194**B include a frangible portion **148**. The frangible portion is a weakened portion which may be severed as illustrated in FIGS. **5**D-**5**J. The frangible portion **148** in combination with carry tabs **194**A, **194**B join adjacent T-Nuts together enabling further processing. Carry tabs **194**A, **194**B and frangible portion **148** thereof are used to join adjacent T-Nuts together and enable further processing of the T-Nuts and installation of the T-Nuts into a substrate. Carry tabs **194**A, **194**B include the portion of the flange **150** proximate the frangible portion **148**.

FIG. **17** is an isometric illustration **1700** of a length of the strip **76** of another example of collated T-Nuts slightly enlarged wherein the barrel **142** is cylindrically shaped **142**S with interior threads **145**I in the upper portion of the bore **148**B of the cylindrically shaped barrel **142**S. FIG. **17**A is a slightly enlarged top schematic view **1700**A of the collated T-Nuts of FIG. **17** illustrating the frangible connection **148** between adjacent T-Nuts. FIG. **17**B is a plan view **1700**B of FIG. **17**. FIG. **17**C is a cross-sectional view **1700**C of FIG. **17**B taken along the lines **17**C-**17**C illustrating interior threads **145**I in the upper portion of the bore **148**B. FIG. **17**D is an end view **1700**D of FIG. **17**B taken along the lines **17**D-**17**D.

FIG. **18** is an isometric illustration **1800** of a length of the strip **76** of another example of collated T-Nuts slightly enlarged wherein the barrel **142** is cylindrically shaped **142**S similar to FIG. **17**, except with interior threads **146**I completely through the bore **148**B of the cylindrically shaped **142**S barrel **148**B. FIG. **18**A is a slightly enlarged top schematic view **1800**A of the collated T-Nuts of FIG. **18** illustrating the frangible connection **148** between adjacent T-Nuts. The frangible portion or connection **148** is easily severed as illustrated in FIGS. **5**D-**5**J. FIG. **18**B is a plan view **1800**B of FIG. **18**. FIG. **18**C is a cross-sectional view **1800**C of FIG. **18**B taken along the lines **18**C-**18**C illustrating interior threads **146***i* through the entire bore **148***b* of the cylindrically shaped **142**S barrel **142**. FIG. **18**D is an end view **1800**D of FIG. **18**B taken along the lines **18**D-**18**D.

FIG. **19** is an isometric illustration **1900** of a length of the strip **76** of another example of collated T-Nuts slightly enlarged wherein the barrel **142** is cylindrically shaped **142**S with interior threads **147**I in the lower portion of the bore of the cylindrically shaped **142**S barrel **142**. FIG. **19**A is a slightly enlarged top schematic view **1900**A of the strip **76** of collated T-Nuts of FIG. **19** illustrating the frangible connection **148** between adjacent T-Nuts. FIG. **19**B is a plan view **1900**B of FIG. **19**. FIG. **19**C is a cross-sectional view **1900**C of FIG. **19**B taken along the lines **19**C-**19**C illustrating interior threads in the lower portion of the bore. FIG. **19**D is an end view **1900**D of FIG. **19**B taken along the lines **19**D-**19**D.

FIG. **12** is a block diagram **1200** of processing stations used to make the complete and finished metal strips **33**, **62**, **64**, **66**, **68**, **70** and **72**. The continuous metal strip dispensing station **1201** dispenses rolled steel or stainless steel which is dispensed to a slack control station **1202**. The slack control station can be a weight which is slidably suspended from the unrolled steel intermediate the rolled/coiled station and the first progressive die of several progressive dies which form the barrel of the T-Nut successively longer and diametrically larger as the metal strip progresses through the dies. The progressive dies are described hereinabove. After the continuous metal strip has progressed through the last die forming station, a tapping/threading station **1204** forms interior threads in the barrel of the T-Nut. Alternatively, a step of forming a counterbore **1203**A may be employed before tapping threads in the inner bore of the T-Nuts. Still alternatively, a stepped exterior **1203**B may be formed before tapping threads in the inner bore of the T-Nuts. The remainder of the metal strip is then characterized after it leaves the tapping/threading station by a die cutting station **1205** which forms a frangible portion and/or forms specific configurations of the T-Nuts such as prongs, holes, welding bosses, slots and rails.

By specific configurations, it is meant the configuration as set forth in any of FIGS. **4**, **6**, **7**, **8**, **9**, **10**, **11**, **14**, **15**, **16**, **17**, **18** and **19**. FIG. **4**A illustrates one example of the frangible portion **48** intermediate adjacent T-Nuts. The frangible portion **48** includes a slot or slit in the top portion **15** thereof. A feed mechanism **1206** includes the spring loaded advancement finger which positions the continuous metal strip of T-Nuts vertically and horizontally as desired. From the feed mechanism, the T-Nuts can be either cut using a cutting mechanism **1207** or a cutting and inserting mechanism **1208**.

REFERENCE NUMERALS

100, **100**A, **100**B—illustrates a die press at a first die station in three successive positions in operating on a strip of metal in performing the method of the present invention.

100C—isometric illustration of the end of the strip of metal as it leaves the press illustrated in FIG. **1**B.

100D—illustrates a die press at a second die station as operating on the strip of metal after it has left the position of FIG. **1**B in the condition of FIG. **1**C.

100E—isometric illustration of the end of the strip of metal as operated on in the press of FIG. **1**D.

100F—illustrates a die press at a third die station as operating on the strip of metal after it has left the position of FIG. **1**D in the condition of FIG. **1**E.

100G—isometric illustration of the end of the strip of metal as operated on in the press of FIG. **1**F.

100H—illustrates a die press at a fourth die station as operating on the strip of metal after it has left the position of FIG. **1**F in the condition of FIG. **1**G.

100I—isometric illustration of the end of the strip of metal as operated on in the press of FIG. **1**H.

10—strip of deformable metal material
12—first side portion of **10**
13—second side portion of **10**
15—top portion of **10**
16—bottom portion of **10**
18—first die station
18A—die members of **18**
19—second die station
19A—die members at **19**
20—third die station
20A—die members at **20** (FIG. **1**F)
21—fourth die station
21A—die members at **21** (FIG. **1**H)
22—cylindrical shape at **18** (FIG. **1**B)
22A—cylindrical shape at **19** (FIG. **1**D)
22B—cylindrical shape at **20** (FIG. **1**F)
22C—cylindrical shape at **21** (FIG. **1**H)
24—fifth die station
25—sixth die station
25A—die
28—taps
33—strip of finished and completed T-Nuts ready for use/insertion
34—press
35—upper platform
36—lower platform
37—spring
38—spring
39—upper run
40—lower run
42—cylinder
44—threads
46—attachment prongs
48, **48**A, **48**B, **48**C, **48**D, **48**E, **48**F—frangible portions of strip between carry tabs of adjacent T-Nuts
50—flange
52—shearing station
53—positioning abutment
54—advancement finger
55—shearing blade assembly
56—blade
57—guide cylinder
58—springs
59—shearing ram
60—guide finger
61, **61**A—openings in the substrate
62, **64**, **66**, **68**, **70**, **72**, **74**, **76**—strips of finished and completed collated T-Nuts ready for use/insertion
63—holes in flanges
65—skives
67, **69**, **71**—prongs
73—rails
74E—endmost T-Nut of collated T-Nut strip **74**, FIG. **14**, FIGS. **5**F and **5**G
81—arrow indicating movement into engagement with positioning abutment
82—arrow indicating upward movement of continuous strip of T-Nuts
83—arrow indicating movement of substrate **89** leftwardly
89—substrate
90—top slot or slit of frangible portion **48**, FIG. **4**E
90A—top slot or slit of frangible portion **48**A, FIG. **6**D
90B—top slot or slit of frangible portion **48**B, FIG. **7**D
90C—top slot or slit of frangible portion **48**C, FIG. **8**D
90D—top slot or slit of frangible portion **48**D, FIG. **9**D
90E—top slot or slit of frangible portion **48**E, FIG. **10**D
90E—top slot or slit of frangible portion **48**F of FIG. **11**D
91—vertical slot or slit of frangible portion **48**, FIG. **4**E
91A—vertical slot or slit of frangible portion **48**A, FIG. **6**D
91B—vertical slot or slit of frangible portion **48**B, FIG. **7**D
91C—vertical slot or slit of frangible portion **48**C, FIG. **8**D
91D—vertical slot or slit of frangible portion **48**D, FIG. **9**D
91E—vertical slot or slit of frangible portion **48**E, FIG. **10**D
91F—vertical slot or slit of frangible portion **48**F, FIG. **11**D
92A, **92**B—carry tabs joined together by frangible portion **48**, FIG. **4**
93—arrow indicating carry tabs **92**A, **92**B, FIG. **4**
93A—arrow indicating carry tabs **94**A, **94**B, FIG. **6**
93B—arrow indicating carry tabs **95**A, **95**B, FIG. **7**
93C—arrow indicating carry tabs **96**A, **96**B, FIG. **8**
93D—arrow indicating carry tabs **97**A, **97**B, FIG. **9**
93E—arrow indicating carry tabs **98**A, **98**B, FIG. **10**
93F—arrow indicating carry tabs **99**A, **99**B, FIG. **11**
93G—arrow indicating carry tabs **194**A, **194**B
94A, **94**B—carry tabs joined by frangible portion **48**A, FIG. **6**
95A, **95**B—carry tabs joined by frangible portion **48**B, FIG. **7**
96A, **96**B—carry tabs joined by frangible portion **48**C, FIG. **8**
97A, **97**B—carry tabs joined by frangible portion **48**D, FIG. **9**
98A, **98**B—carry tabs joined by frangible portion **48**E, FIG. **10**
99A, **99**B—carry tabs joined by frangible portion **48**F, FIG. **11**
142—barrel of T-Nut
142B—bottom of barrel
142S—cylindrical barrel, FIGS. **17-19**
142T—top of barrel
142I—threads in first end **142**T of bore **152**B, FIG. **14**
143I—threads in second end **142**B of bore **152**B, FIG. **15**
144I—threads in second end **142**B of bore **152**B, FIG. **16**
145I—threads in upper portion of bore **148**B
146I—threads completely through bore **148**B
147I—threads in lower portion of bore **148**B
148—frangible connection, FIGS. **14** through **19**
148B—bore in T-Nut, FIGS. **17-19**
152B—bore in T-Nut, FIGS. **14-16**
169A, **169**B, **169**C, **169**D—prongs (pawls), FIGS. **14-19**
194A, **194**B—carry tabs joined by frangible portion **48**G, FIGS. **14**, **15** and **16**
200, **200**A, **200**B—illustrate a fifth die station at which the cylindrical members produced at the previous stations are tapped and provided with threads.
200C—an isometric illustration of the end of the strip of metal as operated on at the fifth die station of FIG. **2**B.
300, **300**A, **300**B—illustrates a sixth station at which the strip of metal between the formed cylindrical members is die cut to produce the heads on the T-Nuts and produce various flange features such as attachment prongs as shown in FIG. **3**B.
300C—an isometric illustration of the end of the strip of metal as operated on at the sixth die station of FIG. **3**B.
400—an isometric illustration similar to FIG. **3**B showing a slightly longer length of the connected and formed T-Nuts and slightly enlarged for detail.
400A—an enlarged portion of FIG. **4** illustrating the connection between adjacent T-Nuts and the location at which they will be severed at about their ultimate location of use.
400B—a plan view of FIG. **4**.
400C—an elevational view of FIG. **4**B.
400D—an end view of FIG. **4**C.

500—a view illustrating the length of integrally connected T-Nuts as shown in FIGS. **4** through **4**D as wound into a helical configuration for ease in shipping and/or manufacturing.

500A—a view of the T-Nuts shown in FIG. **5** in connection with apparatus to sever the endmost T-Nut from its strip and in position to be installed in a substrate.

500B—a view of the apparatus of FIG. **5**A severing the endmost T-Nut from its strip and placing it in an aperture in a substrate.

500C—a view of the apparatus of FIG. **5**B moved back in position to install another T-Nut from the end of the strip into another aperture in a substrate.

500D—a schematic side view of a strip of collated T-Nuts in combination with another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip.

500E—a schematic top view of a strip of collated T-Nuts in combination with another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip.

500E—a schematic cross-sectional view of a strip of collated T-Nuts in combination with another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip taken along the lines **5**F-**5**F of FIG. **5**D illustrating the piston and the tool for advancing the strip, and, illustrating the endmost T-Nut in the chamber for separation from the strip.

500G—a schematic cross-sectional view of a strip of collated T-Nuts in combination with another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip taken along the lines of **5**G-**5**G of FIG. **5**E illustrating the endmost T-Nut in the chamber for separation from the strip and the shearing inbody and guide aligned with the endmost T-Nut.

500H—a schematic cross-sectional view of a strip of collated T-Nuts in combination with another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip illustrating the hinged bottom plate of the escapement rotated downwardly enabling the frangible connection of the endmost T-Nut in the chamber for separation from the strip.

500I—a schematic cross-sectional view of a strip of collated T-Nuts in combination with another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip illustrating the hinged bottom plate of the escapement returned to its home position supporting the strip of collated T-Nuts.

500J—a schematic cross-sectional view of a strip of collated T-Nuts in combination with another example of an apparatus (an escapement) to sever the endmost T-Nut from its strip illustrating the shearing inbody pushing and inserting the endmost T-Nut into a substrate.

501—shearing ram inbody which shears the endmost T-nut from the strip of integrally connected T-Nuts

501G—guide of inbody **501**

502—upper portion of the escapement **599**

502N—nut of stud holding upper portion of the escapement to side walls **503**

503, **503**A—side wall of escapement **599**

504, **504**A—nut of pivot **504**P

504P—pivot of hinged bottom **550** of escapement **599**

505—upper pin for elastic band **513**

506—lower pin located lower portion **507** of the hinged bottom **550** for elastic band

507—lower portion of the hinged bottom **550**

508—cutting blade

508C—cutting surface of cutting blade **508**

509—bolt for affixing the cutting blade to plate **510** of the escapement

510—plate of the escapement/cutting chamber

511, **511**A—plate of the escapement/cutting chamber

512—plate of the escapement/cutting chamber

513—elastic band

520P—passageway for strip **74** within escapement **599**

530—double acting piston

530N—pivot nut for piston **530**

530T—gripping tool advancing strip **74** of T-Nuts

530P, **530**Q—pneumatic connections to cylinder **530**

530R—rod of tool **530**T which engages side wall **503**

531—open slot in side wall **503** for permitting access of gripping tool **530**T to pawls of T-Nuts on strip **74**

531S—guiding surface gripping tool **530**T of side wall **503**

532—open slot in side wall **503**A for permitting access of gripping tool **530**T to pawls of T-Nuts on strip **74**

540, **541**—surfaces on T-Nut engaged by surfaces **540**R, **541**R of gripping tool **530**T

540R, **541**R—gripping surfaces of tool **530**T

550—hinged bottom of escapement

558—opening in substrate **560**

560—substrate **558**

597—core of coil, FIG. **5**K

598—rolled coil of strip **74** of T-Nuts, FIG. **5**K

599—escapement

600, **600**A, **600**B, **600**C, **600**D—another configuration/example of a strip of T-Nuts

700, **700**A, **700**B, **700**C, **700**D—views of a further configuration/example of a strip of T-Nuts

800, **800**A, **800**B, **800**C, **800**D—views of a still further configuration/example of a strip of T-Nuts

900, **900**A, **900**B, **900**C, **900**D—views of yet another configuration/example of a strip of T-Nuts

1000, **1000**A, **1000**B, **1000**C, **1000**D—views of an additional configuration/example of a strip of T-Nuts

1100, **1100**A, **1100**B, **1100**C, **1100**D—views of another example of a strip of T-Nuts.

1200—block diagram of processing stations

1201—metal strip dispensing station

1202—slack control station

1203—progressive dies forming barrel successively longer and diametrically larger

1203A—forming counterbore

1203B—forming stepped exterior **1203**B

1204—tapping/threading station

1205—die cutting station forming frangible portion and/or forming specific configuration of prongs, holes and rails

1206—feeding mechanism

1207—cutting mechanism

1208—cutting and inserting mechanism

1300—prior art backing strip **1201** securing individual T-Nuts **1202** thereto by means of adhesive **1300**A-a prior art device illustrated in U.S. Pat. No. 5,214,843 with wires **1304**, **1305** welded to individual T-Nuts **1302**.

1301—backing strip

1302—T-Nut

1304, **1305**—wires

1400, **1400**A, **1400**B, **1400**C, **1400**D, **1400**E—views of another example of a strip T-Nuts of having a stepped exterior diameters with a partially threaded bore at a first end portion of each of the T-Nuts

1500, **1500**A, **1500**B, **1500**C, **1500**D—views of another example of a strip of T-Nuts having a stepped exterior diameters with a fully threaded bore

1600, **1600**A, **1600**B, **1600**C, **1600**D—views of another example of a strip of T-Nuts having a stepped exterior

diameters with a partially threaded bore at a second end portion of each of the T-Nuts

1700, **1700**A, **1700**B, **1700**C, **1700**D—views of another example of a strip of T-Nuts having a cylindrical barrel with a partially threaded bore in an upper portion of each of the T-Nuts

1800, **1800**A, **1800**B, **1800**C, **1800**D—views of another example of a strip of T-Nuts having a cylindrical barrel with a fully threaded bore

1900, **1900**A, **1900**B, **1900**C, **1900**D-**1700**D—views of another example of a strip of T-Nuts having a cylindrical barrel with a partially threaded bore in an lower portion of each of the T-Nuts

F—force applied by a spring to tension piston **530** and gripping tool **530**T

The invention has been set forth by way of example only and those skilled in the art will readily recognize that changes to the examples may be made without departing from the spirit and the scope of the appended claims.

We claim:

1. An apparatus for severing a T-Nut in combination with a common metal strip of T-Nuts having a plurality of T-Nuts one of which is an endmost T-Nut, comprising:

each of said T-Nuts of said strip of T-Nuts being integrally formed with said common metal strip and connected together at a centrally located frangible portion with a next adjacent T-Nut;

each of said centrally located frangible portions of said common metal strip of T-Nuts is a weakened portion;

each of said T-Nuts includes a bore therein and a prong;

a mechanism to feed and sever said endmost T-Nut from said common metal strip of T-Nuts;

said mechanism includes a positioning member, an advancement finger, and said endmost T-Nut being in engagement with said positioning member;

said positioning member is an abutment;

said advancement finger of said mechanism includes a notched surface, said prong includes a surface which is reciprocally shaped with respect to said notched surface of said advancement finger;

said notched surface of said advancement finger engages said reciprocally shaped surface of said prong driving said common metal strip of T-Nuts into said engagement with said abutment;

a cutting blade positioned vertically below the position of said centrally located frangible portion when said endmost T-Nut is in engagement with said positioning member; and,

a shearing ram having a guide finger positioned axially in line with said bore in said endmost T-Nut and adapted to move said common metal strip of T-Nuts including said endmost T-Nut vertically from an upper to a lower position to engage said centrally located frangible portion of said endmost T-Nut with said cutting blade and sever said endmost T-Nut from said common metal strip of T-Nuts.

2. The apparatus of claim **1**, wherein said bore is cylindrical.

3. The apparatus of claim **1**, wherein said bore is partially threaded.

4. The apparatus of claim **1**, wherein said bore is fully threaded.

5. The apparatus of claim **1**, wherein said bore includes a counterbore.

6. The apparatus of claim **1**, further comprising:

said guide finger resides in said cylindrical bore of said endmost T-Nut to carry said severed endmost T-Nut to another position separated from said strip of T-Nuts.

7. The apparatus of claim **1**, wherein said weakened centrally located frangible portion includes a slot therein.

8. The apparatus of claim **7**, further comprising:

said centrally located frangible portion includes a top surface, bottom surface, front side surface, and back side surface; and,

said slot extends in said top surface, said front side surface, and said back side surface of said centrally located frangible portion.

9. An apparatus for severing and inserting a T-Nut in combination with: a common metal strip of T-Nuts having a plurality of T-Nuts one of which is an endmost T-Nut and one of which is a penultimate T-Nut adjacent to said endmost T-Nut; and, a substrate, said substrate includes an opening therein, said apparatus severs said endmost T-Nut from said common metal strip and inserts said endmost T-Nut into said opening in said substrate; comprising:

each of said T-Nuts of said strip of T-Nuts being integrally formed with said common metal strip and connected together at a centrally located frangible portion with a next adjacent T-Nut;

each of said centrally located frangible portions of said common metal strip of T-Nuts is a weakened portion;

each of said T-Nuts includes a bore therein and a prong;

a mechanism;

said mechanism includes an advancement finger, a positioning member, and said endmost T-Nut being in engagement with said positioning member;

said positioning member is an abutment;

said advancement finger includes notched shaped surfaces; said prong includes surfaces which are reciprocally shaped surfaces with respect to said notched shaped surfaces of said advancement finger;

said notched surfaces of said advancement finger engage said reciprocally shaped surfaces of said prong driving said common metal strip of T-Nuts into said engagement with said abutment;

a cutting blade positioned vertically below the position of said centrally located frangible portion of said endmost T-Nut when said endmost T-Nut is in engagement with said positioning member;

a shearing ram having a guide finger positioned axially in line with said bore of said endmost T-Nut and adapted to move said common metal strip of T-Nuts vertically from an upper to a lower position to engage said centrally located frangible portion of said endmost T-Nut with said cutting blade and sever said endmost T-Nut from said common metal strip of T-Nuts;

said guide finger resides in said bore of said endmost T-Nut to carry said severed endmost T-Nut to said opening in said substrate where said T-Nut is to reside to perform a support function;

a guide mechanism located below said end of said strip of T-Nuts, said guide mechanism includes a support wall surface to engage said penultimate T-Nut of said common metal strip so as to maintain the integrity of said penultimate T-Nut with said common metal strip until said endmost T-Nut is severed from said common metal strip; and,

a piston for moving said shearing ram vertically between said upper and said lower positions.

10. The apparatus of claim **9** wherein said bore is cylindrical.

11. The apparatus of claim **10** wherein said bore is partially threaded.

12. The apparatus of claim **10**, wherein said bore is fully threaded.

13. The apparatus of claim **10**, wherein said bore includes a counterbore.

14. The apparatus of claim **9**, wherein said weakened centrally located frangible portion includes a slot therein.

15. The apparatus of claim **14**, further comprising:

said centrally located frangible portion includes a top surface, bottom surface, front side surface, and back side surface; and,

said slot extends in said top surface, said front side surface, and said back side surface of said centrally located frangible portion.

16. The apparatus of claim **9**, wherein said bore includes a counterbore.

17. The apparatus of claim **9**, wherein said bore is partially threaded.

18. The apparatus of claim **9**, further comprising:

said guide mechanism includes at least one guide cylinder therein receiving said penultimate T-Nut until said penultimate T-Nut is severed from said common metal strip.

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